The tracking efficiency of exchange-traded funds listed on the Johannesburg Stock Exchange

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ABSTRACT

Exchange-traded funds (ETFs) have grown in popularity amongst investors over the last decade, both globally and in South Africa. The purpose of this study was to investigate how efficiently Johannesburg Stock Exchange-listed ETFs track their benchmark indices. Three tracking error measures were calculated for a sample of ETFs that track both local and international equity indices for the period from 2002 to 2018. In addition, three correlation measures were used to evaluate the extent of the relationship between ETF returns and those of their reference benchmarks. The results show that weekly tracking errors are significantly different from zero for both local and international tracking ETFs. The results of the correlation analysis were also significantly different from perfectly linear relationships. The findings show that there is little evidence that ETFs tracking local equity indices track their benchmarks more efficiently than ETFs that follow international equity indices. This study contributes to the existing literature by highlighting the degree to which equity ETFs' performance deviates from the intended benchmark performance. In addition, the study offers evidence that contradicts empirical studies that have shown that ETFs tracking international equity indices have larger tracking errors than those of ETFs that track domestic benchmarks.

INTRODUCTION

In South Africa, the exchange-traded product (ETP) market has seen exceptional growth over the last two decades. Exchange-traded products include both exchange-trade funds (ETFs) and exchange-trade notes (ETNs). The first ETF was listed on the Johannesburg Stock Exchange (JSE) in November 2000, and by December 2012 38 funds were listed with a total market capitalisation of over R42 billion (Charteris, 2013). By December 2018, 101 ETPs were listed on the JSE, of which 76 were ETFs and 25 ETNs. The total market capitalisation of all exchange-traded products listed on the JSE amounted to R77.8 billion (Brown, 2019).

Exchange-traded funds are listed instruments that provide investors with passive exposure to an index. These funds are traded on stock exchanges like ordinary shares, and therefore provide passive investors with an attractive alternative to index mutual funds (Blakey, 2007). Index mutual funds are open-ended, unitised funds that are administered by a management company, and are typically not listed on a stock exchange. In South Africa, mutual funds are also called unit trusts or collective investment schemes. Index funds are constructed with the intention of replicating the performance of a pre-specified index. An ETF is effectively a transformation of an index that was designed for benchmarking into an easily accessible, low-cost vehicle that is available for investment. These benefits have, in part, contributed to the global shift of assets away from actively managed to passive funds. It has been widely documented that, on average, active managers underperform their benchmarks after fees are taken into account (Bal and Leger, 1996; Bollen and Busse, 2005; Malkiel, 2003; 2005). The underperformance of active managers and the investment management costs have contributed to the growth in popularity of low-cost passive investment strategies (Deville, 2008). ETFs have been a beneficiary of this trend, as the expense ratios of ETFs tend to be substantially lower than those of traditional index funds (Frino and Gallagher, 2001). This has been the case in South Africa as well. The ETF market has continued to grow, both in size and number, while active managers struggle to compete. The majority of active managers, however, underperform their benchmarks after taking fees into account (S&P Dow Jones Indices, 2018).

As ETFs have grown in popularity, it has become more important for investors to understand the nature of the actual performance realised by ETFs – specifically, how well they track their benchmark indices. Retail investors following a passive investment strategy may incorrectly assume that, by purchasing an ETF, they will receive the exact performance of the underlying index. However, ETFs are not guaranteed to replicate the performance of their benchmark index precisely (DeFusco, Ivanov and Karels, 2011). This is so because indices are theoretical paper portfolios that are not subject to the same market frictions as actual investment portfolios (Frino and Gallagher, 2001). Tracking error is the difference between the ETF's return and the return of the benchmark index. A small tracking error would be preferable, as this would mean that the fund follows its benchmark closely. A number of factors can contribute to the existence of ETF tracking error, including transaction costs, fund flows, corporate activity among benchmark constituents, the treatment of dividends by the index, and index composition changes (Chiang, 1998). Corporate activity can include mergers, acquisitions, spin-offs, share consolidations and splits, among others. For ETFs that track indices that are domiciled in foreign countries, additional factors play a role, such as mismatched market trading times and exchange rate volatility, which can have an impact on the tracking ability of the fund (Johnson, 2009). The challenge for ETF managers is to manage the many factors that can cause tracking error in order to limit the divergence in performance from their target index.

A number of prior studies have examined the pricing efficiency of ETFs in South Africa, in which the difference between ETF prices and net asset values (NAVs) was studied (Charteris, 2014; Strydom, Charteris & McCullough, 2015). The NAV of an ETF is the sum of the market values of the underlying holdings. However, as far as could be established, no studies have specifically considered the tracking performance of local equity ETFs relative to international ETFs. The purpose of this study was to address this void by using publicly available data and examining the tracking error performance of JSE-listed ETFs with respect to their underlying indices for the period from 2002 to 2018 and, more specifically, how well ETFs following local equity indices track their benchmarks relative to ETFs tracking international equity indices. With the increased use of ETFs by South African investors, coupled with the proliferation of locally listed international ETFs, it follows that more investors would consider using ETFs to achieve international diversification of their portfolios. Investors may believe that the tracking ability of international ETFs is similar to those tracking local indices. This study aims to answer the question whether the tracking ability of international ETFs is any different from that of local ETFs.

The extent of mismatched performance of ETFs could be important to ETF investors in order to assess how consistently ETF fund managers are able to replicate their target benchmarks. This information could aid ETF investors when deciding between ETFs tracking local equity indices and those tracking offshore indices. In addition, the results could be of value to institutional and retail investors who are considering using ETFs in a passive investment strategy. Knowing the extent of the potential underperformance of ETFs relative to their corresponding index could influence their decision-making process. This study also highlights the importance of considering factors such as tracking ability when choosing between ETFs. Moreover, the results could be of interest to both regulators and educators.

The remainder of the study is organised as follows: first, an overview of the applicable literature is provided, followed by an outline of the research objectives addressed in this study. The methodology of the study is presented next, followed by the results. Finally, a reconciliation of the research objectives is given, concluding with the deductions and recommendations for investors, regulators and academics.

OVERVIEW OF EMPIRICAL STUDIES ON ETF EFFICIENCY

According to the efficient market hypothesis (EMH), stock markets are efficient if relevant information is reflected in security prices (Malkiel, 1989). This efficiency implies that it is impossible to generate a consistent outperformance of the market. Malkiel (2003) suggests that the most appropriate investment strategy to follow, if markets are efficient, is a passive investment strategy. This is due to the lower transaction costs and management fees involved when investing in passive strategies. Several studies have shown that active funds tend to underperform the market, and that few funds can deliver consistent outperformance (Bollen and Busse, 2005; Carhart, 1997; Elton, Gruber and Blake, 1996; Frino and Gallagher, 2001). This finding has led to the increased popularity of passively managed investment vehicles such as index unit trusts and ETFs. These strategies attempt to replicate the performance of their benchmark index with minimal cost. ETFs are a popular form of passive investment, because they can be traded on stock exchanges like an ordinary share. One key advantage of an ETF investment is the ease of participation, as investors only need a brokerage account to gain exposure. Relative to index mutual funds, ETFs can also be shorted, bought on margin, and traded throughout the day (Deville, 2008). However, by choosing to invest in an ETF, investors resign themselves to realising the index performance. It is therefore very important for ETF managers to minimise cost and tracking error (Agapova, 2011). A successful ETF would replicate its underlying index exactly (Chu, 2011). However, it is almost impossible for any index tracking fund to replicate its benchmark index exactly due to a number of factors, including management fees, transaction costs, and market frictions (Chu, 2011; Frino and Gallagher, 2001).

A number of factors specifically affect an ETF's ability to track its benchmark, especially for ETFs that follow an index domiciled in separate geographical locations. These factors include the treatment of dividends (Elton, Gruber, Comer and Li, 2005; Rompotis, 2011), missed dividend income due to withholding taxes (Blitz and Huij, 2012), market trading hours not overlapping with the underlying index (Johnson, 2009), and foreign exchange rate volatility (Shin and Soydemir, 2010).

As a result of these factors, it is not expected that ETFs will track their benchmark indices perfectly. However, given that passive investors assume that they can expect the investment performance of the index, the extent to which ETFs track their underlying indices is an important area of empirical study.

International empirical evidence on ETFs

Gastineau (2004) surveyed the performance of two major American ETFs, and found that in both cases they underperformed the benchmark index fund. Frino and Gallagher (2001) highlighted the difficulties faced by index tracking funds by examining both the size and the variation of tracking error over time for S&P 500 index mutual funds. The same researchers found that there was some seasonality in the tracking error they observed. A number of studies have found that ETFs tracking United States (US) equity indices mostly track their benchmarks quite closely (Agapova, 2011; Buetow and Henderson, 2012; Elton *et al.*, 2005; Poterba and Shoven, 2002). These studies concur that passive funds' performances are highly predictable, and that any underperformance of their benchmarks correlates with the magnitude of their expense ratios.

Several studies have compared the tracking ability of ETFs relative to index mutual funds (Aber, Li and Can, 2009; Agapova, 2011; Harper, Madura and Schnusenberg, 2006; Rompotis, 2009). These studies typically conclude that ETFs are superior to index mutual funds in their tracking ability.

Blitz, Huij and Swinkels (2012) examined the performance of index mutual funds and European-listed ETFs. They found that expense ratios are an important determinant of European passive fund returns. However, it was found that European passive funds underperform by a greater magnitude than would have been explained by their fund expense ratios – specifically, funds that track US indices suffer greater shortfalls than funds that follow Japanese indices. The authors suggested that the differences were attributable to dividend taxation. The imposition of dividend withholding taxes in certain local jurisdictions, such as the US, results in a lower after-tax dividend being received relative to the benchmark. When total return benchmarks are constructed, the assumption is that the full gross dividend is reinvested.

In addition to the change in price, total return calculations include dividend distributions in the calculation of return. Similarly, Singh and Kaur (2016) found that ETFs listed in India exhibit significant tracking error over the period from 2011 to 2015. The authors also showed that assets that were under management and volume-traded positively affected the tracking ability of ETFs, while volatility had a negative impact.

A study by Svetina and Wahal (2008) revealed that the tracking error of ETFs following non-domestic indices was up to double that of domestic counterparts. A possible reason suggested for the higher tracking errors was that markets may be in different geographical time zones from those in which the ETFs trade. Indeed, Johnson (2009) investigated the tracking error of US-listed ETFs tracking individual foreign country equity indices, and found that the tracking error of US-listed ETFs was higher where market trading hours did not overlap with the underlying indices. In addition, Johnson (2009) found that foreign exchange rate volatility was one of the complicating factors having an impact on an ETF's ability to track an index in a foreign market. Shin and Soydemir (2010) confirmed this finding in a study on the tracking error of US-listed ETFs on individual foreign countries.

Blitz and Huij (2012) investigated the performance of seven global ETFs, and found that ETFs on emerging market indices displayed greater tracking error than those in developed market ETFs. In addition, the authors showed that higher cross-sectional volatility in emerging markets contributed to the higher tracking error of the observed ETFs. Moreover, it was suggested that the lower liquidity of emerging market stocks, combined with higher transaction costs, had an impact on the tracking ability of emerging market ETFs.

Some empirical studies have compared the tracking error of ETFs between countries. Gallagher and Segara (2005) examined the tracking error volatility of Australian-listed ETFs and compared it with US-listed ETFs. The authors established that ETFs in Australia generate returns commensurate with the underlying benchmark before costs. This result is similar to that which was achieved by ETFs trading in the US market. However, there is empirical evidence that tracking error can vary between markets. Chu (2011) examined the tracking error of 18 Hong Kong-listed ETFs and found tracking errors to be significantly higher than those observed in the US or Australia.

The evidence presented suggests that the extent of the tracking error of ETFs tends to be market-specific, and that there are distinct differences between developed and emerging markets tracking errors.

The literature reviewed suggests that an investigation into the South African context is justified, because it is an emerging market with both domestic and international ETFs listed on the JSE.

Empirical evidence on South African ETFs

In South Africa, Strydom, Charteris and McCullough (2015) examined the performance of index funds and ETFs that tracked the FTSE/JSE Top 40 index from 2001 to 2012. Several measures of tracking error were used to assess the relative tracking ability of both index funds and ETFs. The authors concluded that ETFs have superior tracking ability relative to index tracking funds.

Charteris (2013) studied the pricing efficiency of selected JSE-listed ETFs. This analysis involved examining price deviations from net asset value of four domestic and three foreign South African-listed ETFs for the period from 2008 to 2012. It was found that five of the funds examined, on average, traded at a premium. However, the differences did not persist for more than two trading days. Badenhorst (2015) investigated the causes of observed premiums or discounts of ETFs listed on the JSE – specifically, whether the weighted bid-ask and bid-close spreads were significant determinants. It was observed that the spreads of the underlying investment portfolios were positively related to the larger premiums of ETFs.

As indicated, no recent studies could be found that directly measure the tracking efficiency of JSE-listed ETFs that track local equity indices relative to ETFs that track international equity indices. This study addresses the gap in the literature by providing insight into how well ETFs in South Africa track their benchmarks. On the one hand, it could be asked whether investors receive the investment performance they would expect by investing in JSE-listed ETFs. On the other hand, if South African investors use international ETFs as a means to diversify offshore, is the additional indirect cost involved significantly more than that of domestic ETFs?

RESEARCH OBJECTIVES

The purpose of this study was thus to expand on the limited available research on ETFs listed on the JSE. Specifically, the efficiency of ETFs in tracking their stated benchmarks was evaluated over the period from 2002 to 2018. The primary research objective was to determine how well equity ETFs mirror the indices they are supposed to track. A distinction was drawn between ETFs tracking local equity indices and ETFs following international equity indices.

The analysis considered three different tracking error measures, as well as three measures of correlation. The null hypothesis was that the tracking errors calculated were not significantly different from zero.

Thus,

H01: $\text{Tracking error}_{(i)} = 0$;

HA1: $\text{Tracking error}_{(i)} \neq 0$

For the correlation metrics, the null hypothesis was that the correlation measures were not significantly different from one. An ETF that replicates its benchmark perfectly will have correlation measures equal to one.

Thus,

H02: $\text{Correlation}_{(i)} = 1$;

HA2: $\text{Correlation}_{(i)} \neq 1$

The secondary research objective was formulated to assess whether ETFs tracking local equity indices are more efficient in their ability to track their benchmark than ETFs following international equity indices. The null hypothesis was that the average tracking error for the group of local equity ETFs was equal to the average tracking error for the group of JSE-listed ETFs that track offshore equity indices. Stated differently, the null hypothesis was that the difference between the cross-sectional mean tracking errors was equal to zero. It is thus hypothesised that:

H03: $\text{Average tracking error}_{(i,\ \text{Local})} - \text{Average tracking error}_{(i,\ \text{International})} = 0$;

HA3: $\text{Average tracking error}_{(i,\ \text{Local})} - \text{Average tracking error}_{(i,\ \text{International})} \neq 0$

The differences in the average correlation metrics were also assessed, with the null hypothesis stipulated as:

H04: $\text{Average correlation}_{(i,\ \text{Local})} - \text{Average correlation}_{(i,\ \text{International})} = 0$;

HA4: $\text{Average correlation}_{(i,\ \text{Local})} - \text{Average correlation}_{(i,\ \text{International})} \neq 0$

RESEARCH METHOD

The methodology section addresses the data collection, cleaning, processing and analysis followed in this study.

Data collection and cleaning

The required data for the study were collected from the Bloomberg database. Time-series data of weekly closing prices of JSE-listed ETFs were collected for the period from 2002 to 2018. The listed instruments had to have a live track record of at least one year (52 consecutive weeks) over the course of the sample period. The resulting sample included 39 ETFs in two distinct groups, which are shown in Appendix 1. These clusters were South African equity (including listed property), and international equity (including listed property). The index return data were collected in

South African rand denomination regardless of domicile. The data cleaning process involved checking the data for any obvious errors or anomalies. Roughly 10 per cent of the data were spot-checked by comparing calculated returns with published returns in fund fact sheets. This was done to enhance the robustness and reliability of the data.

Appendix 1 provides an overview of the sample of JSE-listed ETFs, which includes the benchmark index, the assets under management and the start date of data availability.

Data processing and analysis

The total returns were calculated by using the dividend adjusted prices for the ETFs and the total return versions of the appropriate benchmark indices. The weekly returns were calculated by using the following formula:

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \qquad (1)$$

where:

R_t = return in period t;

P_t = price in period t.

Following Frino and Gallagher (2002), the tracking efficiency of ETFs for this study was measured using three of the metrics suggested by Roll (1992) and Pope and Yadav (1994). The first tracking error metric used measures the average absolute difference of weekly returns between ETFs and the benchmark index. The average absolute tracking error over *n* weeks was calculated as follows:

$$TE_{1,t} = \frac{\sum_{t=1}^{n} |R_{pt} - R_{bt}|}{n} \qquad (2)$$

where:

R_{pt} = return for the ETF portfolio in period t;

R_{bt} = return for the corresponding benchmark index in period t;

n = number of observations.

The second method calculates the standard deviation of return differences between ETFs and their benchmark. This measure of tracking error is the standard metric used in practice, and is expressed as follows:

$$TE_{2,t} = \sqrt{\frac{1}{n-1} \sum_{t=1}^{n} \left(e_{pt} - \bar{e}_p\right)^2} \qquad (3)$$

where:

e_{pt} = the difference between returns of the ETF portfolio p and its benchmark for period t;

$\bar{e}_p$ = the mean difference between returns of the ETF portfolio p and its benchmark for the entire sample period.

This metric will return a tracking error (standard deviation) of zero if the ETF regularly underperforms or outperforms by the same amount every week. This tracking error measure may give an unreliable impression of the risk of the ETF because it understates the actual tracking difference between the ETF and the benchmark.

The third method used to estimate tracking error measures the standard error of a regression of ETF returns and the matching index returns. If the returns of an ETF portfolio are regressed against the returns of its corresponding benchmark index, the tracking error (TE_3) could be estimated by the standard error of the regression (Frino and Gallagher, 2002). The regression equation is given by the following formula:

$$R_{pt} = \alpha_i + \beta_i R_{bt} + \varepsilon_{pt} \qquad (4)$$

where:

α_i = intercept term or alpha;

β_i = slope of the regression equation, or beta;

ε_{pt} = standard error of the regression (TE_3).

This method should provide similar results to those of Equation 3. However, Pope and Yadav (1994) caution that, if the slope of the regression is not equal to one, this method may overstate the tracking error.

In addition, a correlation analysis was conducted. This analysis included measuring the Pearson correlation, as well as the coefficient of determination (R^2), and the slope (beta) of a regression equation between the returns of the ETF and its benchmark index. The Pearson correlation will be equal to one if the returns of the ETF are perfectly correlated with the returns of the benchmark. The beta and the R^2 are both outputs from regression Equation 4. The beta will be equal to one if there is a perfect linear relationship between the returns (Chatterjee and Simonoff, 2013: 5). Similarly, the R^2 is a measure of how close the observed data fit the regression line. A value of 100 per cent indicates that the equation explains all the variability of the response data around its mean (Glantz and Slinker, 1990: 248). Therefore, a value of close to 100 per cent would indicate that the actual weekly ETF returns are very close to those of the benchmark.

Testing the various tracking metrics for statistical significance allowed conclusions to be drawn about the efficacy of the ETFs' tracking ability within the different groupings. If the ETFs replicate their underlying index consistently, the tracking error should be equal to zero for each individual ETF, and the average tracking error across all ETFs should also be zero. Therefore, each computed metric was tested for significance using a t-test for both groups, namely, domestic and international ETFs.

However, using the t-test depended on having normally distributed data. To determine whether the data were normally distributed, a Shapiro-Wilk (SW) test for normality was employed. This test evaluates whether a sample comes from a normal distribution (Shapiro and Wilk, 1965). Monte Carlo simulation has shown that the SW-test is one of the most powerful tests for normality, regardless of the shape of the distribution or number of observations (Yap and Sim, 2011). The null hypothesis of this test is that the population is normally distributed. If the p-value is less than the chosen level of significance (for this study, a five per cent level of significance will be used), then the null hypothesis is rejected, and there is evidence that the data tested are not normally distributed.

When dealing with data that were not normally distributed, a bootstrapping process was used. This involved random and multiple re-sampling (5 000 times) from the same sample. The sampling procedure is completed with replacement, which then allows for the estimation of the sampling distribution to indicate the accuracy of the sample statistic (Efron and Tibshirani, 1994). The sample statistic is the measure that summarises the data (Hinton, 2014), and will differ from sample to sample when the bootstrapping technique is used. A summary statistic and accompanying p-value was calculated based on the bootstrapping procedure.

The second objective of this study was to assess whether there are significant differences in the tracking ability of JSE-listed ETFs tracking local equity indices and those that follow international equity indices. To address this objective, the mean difference between the two groupings was tested for statistical significance. Again, the three different metrics for tracking error, as well as the three correlation metrics, were compared following a bootstrap procedure.

EMPIRICAL RESULTS

This section presents the empirical results of the study. The first part reports the descriptive statistics for the two sample groups separately. The results of the SW-test for normality in the distribution are also displayed for each metric evaluated. The next section will present the results of the inferential tests following a bootstrap procedure. Finally, the samples of the two groups will be compared for statistical difference.

Descriptive statistics and tests for normality

Table 1 shows the descriptive statistics of the different measures of tracking efficiency and correlation for the local equity grouping. The cross-sectional mean of the 24 local equity ETFs for the first tracking error measure, the average absolute difference (TE_1), was 0.56 per cent. This difference was close to the median value of 0.58 per cent. The skewness and excess kurtosis measures for TE_1 are indicative of a non-normal distribution. A normal distribution would have skewness and excess kurtosis of zero. This is confirmed by the SW-test, where a SW-statistic of 0.906 and significance value of 0.029 were observed. The null hypothesis of the SW-test is that the sample belongs to a normal distribution. At a five per cent level of significance, the null hypothesis is rejected in favour of the alternate hypothesis, which states that the sample is not from a normal distribution. A similar conclusion was drawn from the SW-tests for the other two tracking error measures (TE_2 and TE_3). At a five per cent level of significance, it could be concluded that the samples were not drawn from a normal distribution.

TABLE 1
DESCRIPTIVE STATISTICS FOR LOCAL EQUITY ETFS

	Average absolute difference (TE_1)	Tracking error (TE_2)	Standard error (TE_3)	Slope of the regression (Beta)	R^2	Correlation
Mean	0.56%	1.03%	0.95%	0.95	0.83	0.90
Median	0.58%	0.88%	0.77%	0.96	0.91	0.95
Min	0.15%	0.29%	0.29%	0.83	0.36	0.60
Max	1.38%	2.55%	2.57%	1.04	0.98	0.99
Count	24	24	24	24	24	24
Skewness	0.957	0.964	1.323	-0.642	-1.648	-1.863
Excess kurtosis	1.861	0.153	1.144	0.954	2.010	2.866
Shapiro-Wilk statistic	0.906	0.884	0.849	0.942	0.776	0.737
Significance (p-value)	0.029	0.010	0.002	0.183	0.000	0.000
Normality conclusion (5% level of significance)	Not normal	Not normal	Not normal	Normal	Not normal	Not normal

The tracking error (TE_2) had a mean weekly value of 1.03 per cent. This figure was slightly higher than the mean value for the standard error of the regression (TE_3) of 0.95 per cent. However, the range of TE_3 was fairly similar to that of TE_2, with a minimum value of 0.29 per cent and a maximum value of 2.57 per cent.

The slope of the regression equation (beta) is expected to be close to one, as this would be indicative of a perfect linear relationship between the returns of the ETF and its benchmark index. Out of the six measures calculated, only one (beta) was found to pass the SW-test for a normal distribution. To conduct statistical tests of significance, it was therefore necessary to perform a bootstrapping procedure. As explained in the methodology section, the bootstrap procedure involved resampling with replacement, with 5 000 samples drawn. Even though the beta measure was normally distributed, the bootstrapping procedure was conducted for all the metrics.

Table 2 contains the descriptive statistics and the output of the SW-tests for the different tracking metrics for the group of JSE-listed ETFs that track offshore equity indices. Fifteen ETFs were included in the sample. The cross-sectional mean of the first tracking error measure (TE_1) was 0.84 per cent, which was slightly higher than the median observation of 0.78 per cent. The descriptive statistics for both TE_2 and TE_3 were fairly similar, with a cross-sectional mean observation of 1.33 per cent and 1.29 per cent respectively. All three tracking error metrics had SW-statistics low enough to conclude that the samples were drawn from distributions that were not normal, at a five per cent level of significance.

The mean and median beta observations were very similar, namely 0.88 and 0.87 respectively. The SW-test statistic of 0.945 and a p-value of 0.449 for beta mean that the null hypothesis cannot be rejected. It can therefore be concluded that the sample was drawn from a normal distribution. For both the R^2 and the correlation measures, the mean values recorded were slightly lower than the median observations. The low p-values from the SW-test mean that it can be concluded that the samples were not normally distributed. Similar to the sample of local equity ETFs, only one measure (beta) had a normal distribution. It was therefore also necessary to perform a bootstrapping procedure in order to test the significance of the observed cross-sectional means.

Inferential statistics

In order to deduce whether the observed descriptive metrics, such as the mean of TE or correlation measures, were statistically significant, it was necessary to perform inferential analysis. Owing to the limited sample sizes of the groups, and the conclusion that most of the samples were not normally distributed, it was necessary to conduct the inferential analysis by way of a bootstrap procedure. The bootstrap procedure was applied to all the samples, regardless of whether they had a normal distribution. This repetition was done to improve the reliability of the statistical analysis. The output from the analysis for the ETF group that tracks local equity indices is displayed in Table 3.

For the three different tracking error measures, the hypothesised value was zero. An ETF that perfectly mirrors its benchmark will have a tracking error very close to zero. In order to determine whether the observed cross-sectional mean values for each metric were statistically different from zero, the mean difference was evaluated at a five per cent level of significance. For the average absolute difference (TE_1), the mean difference across the sample was 0.57 per cent, with a standard error of 0.06 per cent.

TABLE 2
DESCRIPTIVE STATISTICS FOR INTERNATIONAL EQUITY ETFS

	Average absolute difference (TE_1)	Tracking error (TE_2)	Standard error (TE_3)	Slope of the regression (Beta)	R^2	Correlation
Mean	0.84%	1.33%	1.29%	0.88	0.75	0.86
Median	0.78%	1.10%	1.05%	0.87	0.81	0.90
Min	0.60%	0.78%	0.77%	0.73	0.49	0.70
Max	1.47%	2.50%	2.48%	1.01	0.91	0.95
Count	15	15	15	15	15	15
Skewness	1.568	1.040	1.090	- 0.340	-0.842	- 0.897
Excess kurtosis	2.941	- 0.139	-0.005	2.177	-1.069	-0.975
Shapiro-Wilk statistic	0.846	0.850	0.831	0.945	0.806	0.794
Significance (p-value)	0.015	0.018	0.010	0.449	0.004	0.003
Normality conclusion (5% level of significance)	Not normal	Not normal	Not normal	Normal	Not normal	Not normal

TABLE 3
BOOTSTRAP RESULTS FOR LOCAL EQUITY ETFS

	Average absolute difference (TE1)	Tracking error (TE2)	Standard error (TE3)	Slope of the regression (Beta)	R^2	Correlation
Mean difference	0.57%	1.03%	0.95%	- 0.05	- 0.17	- 0.10
Standard error	0.06%	0.13%	0.13%	0.01	0.04	0.02
Significance (2-tailed)	0.000	0.000	0.000	0.000	0.006	0.013

TABLE 4
BOOTSTRAP RESULTS FOR INTERNATIONAL EQUITY ETFS

	Average absolute difference (TE1)	Tracking error (TE2)	Standard error (TE3)	Slope of the regression (Beta)	R^2	Correlation
Mean difference	0.84%	1.33%	1.29%	- 0.123	- 0.246	- 0.136
Standard error	0.06%	0.14%	0.14%	0.015	0.039	0.024
Significance (2-tailed)	0.000	0.001	0.001	0.000	0.003	0.005

The mean difference of TE_2 across the bootstrap sample was 1.03 per cent, with a standard error of 0.13 per cent. The very low p-value (0.000) from the test means that the observed mean is not equal to zero at a five per cent level of significance. Similarly, the mean standard error (TE_3) of 0.95 per cent was statistically significantly different from zero. These results suggest that local equity ETFs do not track their benchmarks perfectly.

The three different correlation measures were evaluated against a hypothesised value of one. This is because perfect correlation would imply that the observations are statistically indistinguishable from one. The beta measure had a mean difference of - 0.05, with a standard error of 0.01. Therefore, the mean cross-sectional beta of 0.95 observed is statistically different from 1.00 at the five per cent level of significance.

The R^2 and the correlation coefficient measures had mean differences of - 0.17 and - 0.10 respectively. The significance levels for both were lower than 0.05. Therefore, it could be concluded that, for both measures, the observed mean values were statistically different from 1.00 at the five per cent level of significance. These results support the evidence presented earlier, that ETFs tracking local equity indices do not track their benchmarks perfectly.

Table 4 summarises the results of the inferential analysis for JSE-listed ETFs that track international equity indices. With regard to the tracking error measures, all three had mean values that were statistically different from zero. The significance levels for all three were below 0.05, which means that the ETFs track their benchmarks imperfectly. This conclusion was in line with expectations, as a number of factors are expected to have an impact on an ETF's ability to track an offshore index (Frino and Gallagher, 2001).

The correlation metrics were all deemed to be statistically significantly different from 1.00. The mean difference of the R^2 measure was - 0.246, with a standard error of 0.039. For the beta and correlation metrics, the mean differences from 1.0 were - 0.123 and - 0.136 respectively. With significance values below 0.05 for all three correlation measures, it can be concluded that ETFs that track international equity indices have less than perfect correlation with their benchmarks.

Comparing local equity and international equity tracking ETFs

There are a number of reasons to believe that ETFs that follow international equity indices will have larger tracking errors than ETFs that track local equity indices. These reasons include additional market frictions, the fact that market operating times may not overlap between countries (Johnson, 2009), and the impact of foreign exchange rate volatility (Shin and Soydemir, 2010). To determine whether this is the case in the South African context, an inferential analysis was done on the observed means between the two groups. The difference in observed means was tested for significance for each of the three tracking error metrics as well as the three correlation metrics.

Table 5 presents the results from the bootstrap analysis. For the first tracking error metric, TE_1, the mean difference between the groups was - 0.28 per cent, with a standard error of 0.08 per cent.

The mean difference was calculated as the mean of the international equity ETFs from the mean observation of the group of local ETFs. The two-tailed p-value was 0.001, leading to the conclusion that the difference in the observed means is different from zero at the five per cent level of significance. The average absolute difference between international equity ETFs and their benchmark returns was statistically significantly higher than the average absolute difference between local equity ETFs and their benchmark returns. Local ETFs appear to track their benchmarks more closely than ETFs following international equity indices. This result was expected, and is in line with the evidence presented in the literature (Svetina and Wahal, 2008; Johnson, 2009; Shin and Soydemir, 2010).

For both the tracking error metrics TE_2 and TE_3, the null hypothesis could not be rejected. The null hypothesis states that the mean difference between the observed means of the two groups is equal to zero. With estimated p-values of 0.141 and 0.08 respectively, the null hypothesis could not be rejected at the five per cent level of significance. The conclusion, therefore, is that the tracking errors for the two groups are not significantly different. The observation for TE_3 was, however, significant at the 10 per cent level.

Although the observed difference in the means were - 0.29 per cent and - 0.34 per cent for TE_2 and TE_3 respectively, the higher standard errors observed meant that it could not be concluded that the observed differences were statistically different from zero. This was an unexpected outcome, given the documented additional market frictions international ETFs need to overcome. The result calls for further research. However, a possible explanation for the findings could be the changing nature of the companies listed on the JSE. The increased presence of dual-listed international companies and the expanding global operations of domestic firms could explain the higher co-movement with international equities. Another reason for the similarity in results could be the use of comparable replication techniques used by management companies. Many firms that manage ETFs in SA have both local tracking and international tracking funds. If the same teams use similar techniques for both the domestic tracking and the international tracking ETFs, the resulting tracking errors may be closer to each other than expected.

The mean cross-sectional beta for local equity tracking ETFs was larger than international tracking ETFs by a value of 0.074. The null hypothesis – that the two groups had the same mean beta – was rejected at the five per cent level of significance. Therefore, it could be concluded that the difference between the observed means was not equal to zero. This means that the average slope of the regression of the returns of local ETFs against the returns of their benchmarks was statistically different from that of international ETFs. Domestic tracking ETFs on average have beta values closer to one than those of international ETFs. This observation would suggest that the international ETFs produce weekly returns that are on average further from that of the benchmark, and that domestic ETFs have produced weekly returns that are relatively closer to their benchmarks. Although this result would suggest that domestic ETFs as a group are superior to international ETFs in their tracking ability, the evidence is less compelling in light of the contradictory results from the tracking error measures (specifically TE_2 and TE_3).

For the remaining two correlation measures, the mean difference observed was 0.075 and 0.040 for R^2 and the correlation coefficient respectively. It would appear that, on average, there is a higher correlation between local equity ETFs and their benchmarks than international equity ETFs and their benchmarks. However, the p-values of 0.183 and 0.227 mean that the null hypothesis cannot be rejected at the five per cent level of significance. It is therefore possible to conclude that there is no statistically significant difference between the observed means of both the R^2 and the correlation measure. ETFs tracking local equity indices are correlated with their underlying benchmarks to the same degree as ETFs that track international equity indices. This observation is consistent with the results of the tracking error measures.

TABLE 5
BOOTSTRAP RESULTS FOR COMPARISON BETWEEN LOCAL EQUITY AND INTERNATIONAL EQUITY TRACKING ETFS

	Average absolute difference (TE1)	Tracking error (TE2)	Standard error (TE3)	Slope of the regression (Beta)	R^2	Correlation
Mean difference	- 0.28%	- 0.29%	- 0.34%	0.074	0.075	0.040
Standard error	0.08%	0.19%	0.18%	0.018	0.054	0.033
Significance (2-tailed)	0.001	0.141	0.080	0.000	0.183	0.227
Hypothesised difference	0.00	0.00	0.00	0.00	0.00	0.00
Decision	Reject Null	Retain Null	Retain Null	Reject Null	Retain Null	Retain Null
Conclusion	Difference not equal to zero	No difference	No difference	Difference not equal to zero	No difference	No difference

There is thus no strong evidence in support of the notion that ETFs tracking local equity benchmarks might have a superior tracking ability relative to ETFs following offshore benchmarks.

CONCLUSIONS

This study examined the performance of ETFs that provide passive exposure to both local and offshore equity indices. Having first established that the samples for both groups were predominantly not from normal distributions, a bootstrap procedure was followed in order to assess the observed means of tracking errors for significance. All the tracking error metrics for both groups were statistically significant. This result was in line with expectations, as a number of documented factors could hamper an ETF's ability to track its benchmark (Frino and Gallagher, 2001). Similarly, the correlation measures for both groups were less than perfectly linear.

The results from the comparison of tracking ability between local ETFs and international ETFs were mixed. Although the mean tracking error metrics appeared to be higher for international ETFs, only the average absolute difference (TE_1) was shown to be statistically significant. For two of the three tracking error measures (TE_2 and TE_3), there was no evidence of a statistical difference between the groups. The results were unexpected, as a number of studies document that ETFs that track international equity indices tend to have much higher tracking errors than those that track domestic benchmarks (Blitz *et al*., 2012; Svetina and Wahal, 2008). Among the correlation measures tested, only the average beta was significantly different between the two groups. For the R^2 and the correlation coefficient, there was no statistical difference between the two groups.

IMPLICATIONS FOR INVESTORS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The extent of mismatched performance of ETFs could be significant to ETF investors who need to determine how consistently ETF fund managers are able to replicate their target benchmarks. This study has shown that, for both equity ETF groups (local and offshore), the dispersion in tracking errors is quite high in each group. Some ETFs are able to replicate their underlying benchmark quite closely, whereas others register high tracking error metrics and have low correlations with their benchmarks. This information could aid ETF investors in their investment decision process by highlighting the importance of tracking ability when selecting the ETF in which they would like to invest. Passive investors considering investing in JSE-listed ETFs may need to be more discerning when choosing an appropriate ETF, as not all ETFs have the same tracking ability.

This study has also shown that, although it appears that ETFs tracking international equity indices have inferior tracking efficiency compared with local equity ETFs, there is little empirical evidence to support this assertion based on the data analysed in this study. Investors wishing to use ETFs in obtaining offshore exposure will not receive investment returns mirroring the intended benchmark exactly. However, they will, from a statistical perspective, be no worse off than investors using ETFs that track local equity indices. The implication for investors is that there is no proof of an additional shortfall in performance when investing in ETFs that track international equity indices.

This study did not consider or evaluate changes in the tracking error of ETFs during periods of heightened cross-sectional dispersion. Some studies have found that emerging market ETFs exhibit higher levels of tracking error during periods of high return dispersion (Blitz and Huij, 2012). This study could thus be expanded to evaluate whether the tracking error of JSE-listed ETFs relate to the cross-sectional volatility of the market.

Another potential expansion of the study is to assess the tracking error of JSE-listed ETFs against some of the suggested factors documented in the literature: expense ratios (Blitz and Huij, 2012), withholding taxes on dividends (Blitz *et al*., 2012), and exchange rate volatility (Shin and Soydemir, 2010). However, this was beyond the scope of this study.

The results of the study could be of interest to financial market regulators. The JSE, for example, is responsible for investor protection in ensuring that the instruments listed on the exchange are representative of their stated intention. The results could motivate increased awareness of realised tracking errors of ETFs. For ETF investors who assume that they will obtain passive exposure to a stated index, it could be construed as misleading if ETFs consistently fail to produce similar actual results to those of the intended benchmark.

Educators should emphasise the importance of tracking error when teaching students about passive investing. The results of the study show that, although ETFs are considered a passive form of investing, in reality, South African equity ETFs do not track their intended benchmarks perfectly.

When investing in ETFs, retail investors should consider the additional risk of the ETF manager failing to produce a performance that is identical to the stated benchmark. In addition, institutional investors, who typically invest in ETFs to obtain certain exposures to factors or regions, should consider the implications of the findings of the study. First, ETFs may produce a higher tracking error to the index than expected, which may have implications for factor or country allocation decisions in the portfolio management context. Second, locally listed ETFs that track international equity indices may not have significantly higher realised tracking errors than ETFs tracking local equity indices. The additional sacrifice in tracking efficiency assumed when investing in locally listed international ETFs may not be as high as expected. Future studies could investigate whether locally listed international ETFs track their index as efficiently as offshore listed ETFs tracking the same index.

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APPENDIX 1
SAMPLE OVERVIEW

Local Equity				
JSE Code	**ETF Name**	**Benchmark**	**AuM (R mln)**	**Data start**
ASHT40	Ashburton Top 40 ETF	FTSE/JSE Top 40 Index	129.4	2008/10/24
NFSWIX	NewFunds SWIX ETF	FTSE/JSE SWIX 40 Index	1.2	2012/04/27
STAN40	Stanlib Top 40 ETF	FTSE/JSE Top 40 Index	48.8	2010/10/29
STANSX	Stanlib SWIX 40 ETF	FTSE/JSE Top 40 Index	135.9	2010/11/05
STX40	Satrix 40 ETF	FTSE/JSE Top 40 Index	583.9	2002/07/19
STXSWX	Satrix SWIX Top 40 ETF	FTSE/JSE SWIX 40 Index	27.7	2006/04/21
SYGSW4	Sygnia Itrix SWIX 40 ETF	FTSE/JSE SWIX 40 Index	14.7	2017/11/10
SYGT40	Sygnia Itrix Top 40 ETF	FTSE/JSE Top 40 Index	14.8	2017/11/10
ASHMID	Ashburton Mid Cap ETF	FTSE/JSE Mid-Cap Index	25.8	2012/08/24
CTOP50	CoreShares Top 50 ETF	S&P South Africa 50 Index	88.5	2015/05/29
GIVFIN	NewFunds S&P GIVI SA Financial 15 ETF	S&P GIVI South Africa Financial 15 Index	3.1	2009/06/26
GIVIND	NewFunds S&P GIVI SA Industrial 25 ETF	S&P GIVI South Africa Industrial 25 Index	2.6	2009/06/26
GIVISA	NewFunds S&P GIVI SA Top 50 ETF	S&P GIVI South Africa Top Index	6.1	2008/07/04
GIVRES	NewFunds S&P GIVI SA Resource 15 ETF	S&P GIVI South Africa Resource 15 Index	2.6	2009/06/26
NFEMOM	NewFunds Equity Momentum ETF	ABSA Capital South Africa Equity Momentum Index	6.0	2012/02/17
STXDIV	Satrix DIVI ETF	FTSE/JSE Dividend Plus Index	114.6	2007/09/07
STXFIN	Satrix FINI ETF	FTSE/JSE Financial 15 Index	53.7	2002/07/19
STXIND	Satrix INDI ETF	FTSE/JSE Industrial 25 Index	131.8	2002/07/19
STXQUA	Satrix Quality South Africa ETF	S&P Quality South Africa Index	9.6	2017/10/06
STXRES	Satrix RESI ETF	FTSE/JSE Resi 10 Index	27.1	2006/04/21
STXRAF	Satrix RAFI 40 ETF	FTSE/JSE RAFI 40 Index	72.4	2008/10/24
PTXSPY	CoreShares Proptrax SAPY ETF	FTSE/JSE SA Listed Property Index	10.8	2007/10/05
STPROP	STANLIB SA Property ETF	FTSE/JSE SA Listed Property Index	6.5	2013/02/22
STXPRO	S&P South Africa Composite Property Capped Index	FTSE/JSE SA Listed Property Index	9.2	2017/03/03
International Equity				
ASHGEQ	Ashburton Global 1200 Equity ETF	S&P Global 1200 Index	36.8	2017/10/13
CSP500	CoreShares S&P 500 ETF	S&P 500 Index	49.7	2016/11/11
GLODIV	CoreShares S&P Global Dividend Aristocrats ETF	S&P Global Dividend Aristocrats Blend Index	22.3	2018/03/02
STX500	Satrix S&P 500 ETF	S&P 500 Index	39.4	2017/08/04
STXEMG	Satrix MSCI Emerging Markets ETF	MSCI World Emerging Markets IMI Index	33.2	2017/08/04
STXWDM	Satrix MSCI World ETF	MSCI World Index	57.2	2017/08/04
SYG4IR	Sygnia 4th Industrial Revolution Global Equity ETF	Kensho New Economies Composite Index	41.4	2017/12/15
SYG500	Sygnia Itrix S&P 500	S&P 500 Index	64.8	2017/11/10
SYGEU	Sygnia DJ EuroStoxx 50 ETF	EuroStoxx50 Index	161.5	2005/10/21
SYGJP	Sygnia MSCI Japan ETF	MSCI Japan Index	52.4	2008/04/11
SYGUK	Sygnia FTSE 100 ETF	FTSE 100 Index	66.0	2005/10/21
SYGUS	Sygnia MSCI USA ETF	MSCI USA Index	353.6	2008/04/11
SYGWD	Sygnia MSCI World ETF	MSCI World Index	552.5	2008/04/11
GLPROP	Coreshares S&P Global Property ETF	S&P Global Property 40 Index	29.4	2016/11/11
SYGP	Sygnia Itrix Global Property ETF	S&P Global Property 40 Index	20.1	2017/11/10

Source: Johannesburg Stock Exchange (2019) and Bloomberg (2019)