Exchange-traded funds: a market snapshot and performance analysis

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ABSTRACT

We present a snapshot of the Exchange-Traded Fund (ETF) market in September 2011 involving 6937 ETFs with a total market value of US$2.96 trillion. We describe the market's growth since 1993 and its current composition. Only 11% of ETFs reproduce both the mean return and the volatility of their benchmark within 1% p.a. Discrepancies in replicating the mean return of the benchmark tended to be associated with either leveraged or inverse (or both) ETFs. With respect to replicating benchmark volatility most ETFs have higher volatility than their benchmarks.

INTRODUCTION

Exchange-Traded Funds (ETFs) have grown significantly in recent years, in terms of the number of funds, size of funds and trading volume. A vanilla ETF offers replication of a market index such as the S&P500, and thereby offers an investor exposure to a market index in a much more flexible manner than a conventional mutual fund. More complex ETFs offer leveraged or inverse leveraged exposure to a comprehensive range of markets. In some countries ETFs also offer tax advantages over mutual or index funds.

During 2011 cash flows into ETFs increased but asset prices fell, thus estimates of the total size of the ETF market vary, but as an indication BlackRock (2011) estimates it was approximately US\$1.5 trillion (i.e. US\$$1.5\times10^{12}$) at the end of that year. The market size has doubled since late 2008. Due to the growth of the market for ETFs, regulators around the world have become concerned at their potential for inducing (or exacerbating) market risk and instability.

In light of the growing importance of ETFs, we classify and analyse the performance of ETFs as identified in September 2011. In our snapshot, we were able to find sufficient information to classify 6937 active ETFs. We selected a subset of 822 ETFs where we were able to conduct a detailed statistical performance analysis. Our contributions are: an analysis of the composition of the largest ETF dataset considered in the literature to date; and a regression based performance analysis (from 1993 to 2011) to gain insight into the relationship between ETF characteristics and their ability to replicate both benchmark return and benchmark volatility.

This paper is structured as follows. As background, we first discuss how plain vanilla ETFs and synthetic (leveraged/inverse) ETFs are constructed and the relevant academic literature. Then we describe our ETF dataset and explain the composition of the ETF market by classifying that data (involving 6937 ETFs). The regression based analysis of 822 ETFs follows.

ETF CONSTRUCTION AND LITERATURE

Here we discuss how ETFs are constructed and the relevant academic literature.

ETF construction

The ETF creator makes three basic decisions: (1) the ***benchmark index*** to use, (2) the ***target return*** (tied to the chosen index) and (3) the ***basket of assets*** to hold to achieve that return.

With respect to this first decision ETFs use a wide of benchmark indices for different asset classes. Examples include an equity index, a bond index (see Tucker and Laipply, 2013), a commodity or a commodity index.

With respect to this second decision ETFs historically started out as index trackers, aiming to give the same return as a benchmark index. As ETFs evolved, their scope widened beyond index tracking. Leveraged ETFs, aiming to give a multiple of index return (e.g. $2\times$), appeared. Inverse (or short) ETFs aiming to give the negative of index return (so $-1\times$) also appeared. Here we refer to an

ETF as a $L\times$ ETF if the ETF aims to return a multiple L of the benchmark index return. An index tracking ETF is hence referred to as a $1\times$ ETF. ETFs aiming to give a leveraged inverse (say $-2\times$) have also now appeared. Note here that $L\times$ ETFs with $L>1$ are sometimes called "bull ETFs", $L\times$ ETFs with $L\leq-1$ are sometimes called "bear ETFs".

With respect to this third decision then in the simplest case, tracking an equity index, the ETF basket can fully replicate the index. Alternatively, approaches based on replicating the index by holding a subset of the assets in the index could be used to decide the composition of the basket (e.g. see Beasley et al (2003) and Canakgoz and Beasley (2009) for approaches to index tracking). For leveraged and inverse ETFs deciding the composition of the basket that the ETF creator should hold so as to achieve the target return is a genuinely difficult task. Consequently "synthetic" ETFs have been developed to deliver the target return of $L\times$ with respect to the benchmark index specified. Typically swaps/futures/derivative contracts are used to deliver the promised return. Leveraged/inverse ETFs require daily rebalancing in order to achieve promised returns. Cheng and Madhavan (2009), Rollenhagen (2009) and Little (2010) discuss leveraged and inverse ETFs in greater detail.

Once the three decisions outlined above have been made the success (or failure) of the ETF depends upon its ability to attract investors. For more detail about the creation and market making of ETFs see Gastineau (2004), Deville (2008), Gastineau (2010), IndexUniverse (2011) and Investment Company Institute (2013).

As ETFs are traded their price may deviate from their underlying net asset value, NAV, due to supply and demand. Any difference between an ETF share price and the underlying NAV will give rise to arbitrage possibilities; hence ETF prices will (in practice) be arbitraged back to their underlying NAV (for example, see Engle and Sarkar (2006), Kayali (2007) and Ackert and Tian (2008) for a discussion of the evidence supporting the hypothesis that ETFs trade close to their underlying NAV).

ETF literature

Here we have focused primarily on published academic literature. ETFs were introduced in the 1990s; some early issues around their introduction are discussed in Kupiec (1990) and Gastineau (2001). Poterba and Shoven (2002) provided some statistics on the growth of ETFs since their introduction in the 1990s. Boehmer and Boehmer (2003) considered the introduction by the New York Stock Exchange of trading in three large ETFs (SPY, QQQ and a Dow Jones ETF, DIA), plus a number of smaller ETFs, that had previously only been traded on other exchanges. Kostovetsky (2003) examined the conditions under which it is preferable for an investor to invest in an (index tracking) ETF as compared with a conventional index tracking mutual fund. Alexander and Barbosa (2008) examined the hedging problem which arises in ETF creation/redemption when the basket underlying the ETF shares involves illiquid stocks with relatively high transaction costs.

Mariani et al (2009) examined the return distributions of three ETFs and their corresponding benchmark indices using a Levy model. Avellaneda and Zhang (2010), Giese (2010) and Jarrow (2010) presented models for a leveraged (and inverse) ETF by assuming that the ETF follows a diffusion process. Guedj et al (2010) considered the problems associated with daily rebalancing of leveraged/inverse ETFs and the shortfalls that might result for investors holding such ETFs. Lin and Mackintosh (2010) discussed issues related to tracking error calculations for ETFs.

Dobi and Avellaneda (2012) agued that as daily rebalancing by managers of leveraged and short ETFs is predictable this negatively impact their returns. Borkovec and Serbin (2013) investigated the liquidity and trading costs for 12 ETFs that track US equity indices. Marshall et al (2013) discussed the evidence for mispricing between two liquid ETFs that both track the S&P500.

With respect to papers that focus on ETF performance we present Exhibit 1, where we summarise the scope of each study (ETFs covered) and its conclusions. Clearly within the confines of an academic paper it is impossible to fully summarise the 29 studies seen in Exhibit 1. However that exhibit is provided here to enable the reader to investigate further if they are interested in a particular study.

INSERT EXHIBIT 1 HERE

ETF SNAPSHOT

For our snapshot of the ETF market, information was collected from Thomson Reuters DataStream (2011a) in September 2011. The information available on each ETF varied, from a full price history of the ETF and its underlying benchmark, to little more than the name of the ETF and an indication as to whether the ETF was still active or not. This variation in the information available for each ETF inevitably leads to a decrease in the size of the dataset as the complexity of any analysis attempted increases. We found a total of 8192 ETFs of which 7198 were active and 994 were dead or suspended. Although the ETF market started in 1993, it has experienced a sharp increase in recent years. Exhibit 2 shows the cumulative number of ETFs created over the years, (including those that are currently dead or suspended). A sharp rise can be seen from 2005 onward. Since then the number of ETFs created has soared, from less than 1000, to 8192 as of September 2011. From the end of 2005 to the end of 2010 (the last full year for which we have data) the number of ETFs increased at a compound rate of 55% per year. In the 12 months to September 2011, the date of our snapshot, 1578 new ETFs were launched, a creation rate of over 6 ETFs per trading day. Of these 8192 ETFs, 902 are leveraged/inverse ETFs. There are 2018 different underlying benchmarks associated with these 8192 ETFs.

INSERT EXHIBIT 2 HERE

All ETFs were classified into one of several major categories (e.g. Single Market Equity Tracker), and then further subdivided within those major categories (e.g. Real Estate Sector). The results of this classification are shown in Exhibit 3; the first column shows the major classification, the second column the sub-classification; within each sub-classification the number of active ETFs for each desired return (e.g. $L\times$) is given; the final two columns give the total number of active and dead/suspended ETFs within that sub-classification.

INSERT EXHIBIT 3 HERE

As can be seen from Exhibit 3 the vast majority of the 6937 active ETFs track equity indices, 2607 ETFs (37.6% of active ETFs) track single market equity indices, 2272 (32.8%) multi-market equity indices. The next most common categories are commodity (13.5%) and bond (12.4%) trackers. In terms of the type of performance expected, 87.7% of active ETFs are simple trackers ($1\times$); 4.4% are inverse ETFs ($-1\times$), so offering the equivalent of shorting the underlying benchmark; 4.3% are leveraged ($2\times$,$3\times$); 2.5% are inverse leveraged ($-2\times$,$-3\times$); 0.8% offer excess return.

In Exhibit 4 we show the creation date of the 6937 (currently) active ETFs as seen in Exhibit 3, subdivided by category. 514 of these ETFs were created before the end of 2005. The vast majority of non-equity ETFs were formed after 2005. The first of these ETFs to offer excess/leveraged return was launched in 2005. Inverse and inverse leveraged ETFs began appearing in 2006.

INSERT EXHIBIT 4 HERE

Considering Exhibit 4 we can see that, even though equity trackers still dominate the ETF market, there has been clear diversification in recent years. If we take the ETF market as it was at the end of 2005, equity trackers constituted (by number) 90% of the entire market. By the end of 2007, this had fallen to 75%, falling further to 70% now. This fall in equity ETFs has been balanced by a rise in bond and commodity ETFs which were jointly responsible for just 10% of the entire ETF market at the end of 2005, 23% by the end of 2007 and, finally, 26% at the time of our market snapshot.

Considering both Exhibit 2 and Exhibit 4 it would be hard to discern that in 2007-8 there was a global financial crisis. Even looking within the data for any sign of a shift in ETF emphasis it is hard to identify any significant effect. For example one might hypothesise that the financial crisis would divert investment attention from older economies to newer, and emerging, economies. Before the financial crisis had taken hold, at the end of 2007, 79% of all single market ETFs tracked markets in Europe, North America (USA/Canada) or Japan. After the financial crisis had hit, by the end of 2009, 77% of single market ETFs tracked these markets. Thus, despite the growth in ETFs that occurred during these two years, as evidenced in Exhibit 4, the proportion of ETFs tracking single markets in the older economies effectively remained the same. Of the 545 single market ETFs started in the 12 months to September 2011, 64% tracked markets in Europe, North America or Japan. Overall these data do not appear to indicate that the global financial crisis has diverted the ETF market away from older economies.

In terms of the size of each ETF we were able to get the market value (total NAV) for approximately 30% of active ETFs. Information from DataStream (Thomson Reuters DataStream

2011b) indicated that they rely on ETF providers to supply this information and some do not. It was clear from our data that lack of market value information was more of an issue with newer ETFs than older ETFs. For example we had market values for 65% of the ETFs created before 2006; for ETFs created in 2010 we had market values for just 21%. The available market values (MVs) are summarised in Exhibit 5, all converted into US$ for ease of comparison. Over half the market value is in single market equity trackers; nearly 70% of market value is in equities in some form. We can see 20.9% of market value is in commodity trackers despite being only 7.4% of active ETFs by number. Commodity trackers have the highest mean market value; this contrasts with multi-market equity trackers which have a comparatively low mean market value. Comparing the mean and median ETF size (as in the ratio column in Exhibit 5) reveals that the distribution of ETF MVs within each sector is highly skewed. This is most clearly apparent for commodity trackers, where the ratio is 59.7 (so the mean ETF MV is nearly 60 times larger than the median ETF MV). In fact in this category 95% of the total MV is concentrated in 10% of the ETFs by number.

INSERT EXHIBIT 5 HERE

One point of interest from Exhibit 5 relates to the total size of the ETF market. BlackRock (2011) estimated the size of the ETF market as approximately US$1.5 trillion (i.e. US$$1.5\times10^{12}$) at the end of 2011, and involving (at most) 4200 ETFs. Although the precise classification of a particular fund as an ETF can vary, as do daily market values, our snapshot indicates that these figures potentially underestimate the total size of the market. In Exhibit 5, which uses data for 2125 ETFs (31% of 6937 active ETFs) we find a total market value of US$2.96 trillion (so approximately US$3 trillion). As with commodity trackers, there is a distinct Pareto effect in ETF market values: 13% of ETFs represent 90% of market value; 7% of ETFs make up 80% of total market value. In fact the ETF market is so highly skewed that just 28 ETFs make up 50% of total market value.

We now look at the larger categories of ETFs in more detail. Firstly, in Exhibit 6, we consider single market (country) equity ETFs, the performance of these ETFs is linked to an index in a particular country, either a market index or a more specialised sector index. Exhibit 6 shows the top twenty countries ranked by ETF MVs, the number of ETFs is also shown. We can see that the United States dominates with 25% of total MV; ETFs following indices in China represent 17%, Japan 15%. The remaining BRIC countries (Brazil, Russia, India) represent 7% of total MV. Considering ETF numbers, 40% follow the United States; roughly five times more than follow the next most popular single country, China.

INSERT EXHIBIT 6 HERE

Secondly, we consider equity ETFs following multi-market (country) indices. Exhibit 7 shows the top twenty (by MV) indices tracked. It can be seen that MV is highly concentrated, with 29% of MV associated with ETFs following emerging markets. EAFE (Europe, Australasia and Far East) countries account for 24% of MV; Europe accounts for 20% and ETFs following global indices account for 16%. With respect to the number of ETFs 40% track European, and 25% global, indices.

INSERT EXHIBIT 7 HERE

Thirdly, we consider commodity based ETFs and in Exhibit 8, we show the top ten commodities or commodity indices tracked. Again MV is highly concentrated; with ETFs tracking gold accounting for 53% of MV and ETFs tracking WTI (West Texas Intermediate) or Brent oil futures contracts accounting for 38% of MV. The third largest commodity tracked by MV is silver with 5% of market value. Taken together these three commodities account for approximately 96% of total MV associated with commodity ETFs. In terms of the number of ETFs, 11% follow gold, 8% follow general commodity indices (Dow Jones – UBS Commodity index or the S&P GSCI), 6% follow platinum or palladium and 5% follow silver.

INSERT EXHIBIT 8 HERE

ETF PERFORMANCE ANALYSIS

The term performance is used here to denote the accuracy with which an ETF replicates the return behaviour of its benchmark. We first discuss how our database of ETFs for performance analysis was selected and then present the statistics we calculated.

We draw our performance database from the 2125 active ETFs for which we had a market value (recall from Exhibit 5 that their total MV was US$2.96 trillion). Since our snapshot is as at the end of September 2011 we excluded any ETFs that were created after September 2009 (so we had at least two years of data), and this left 1413 ETFs as potential candidates for analysis. For these candidates we collected daily price and benchmark index values from DataStream with which to calculate daily returns. The price series for some ETFs were intermittently reported so unless an ETF had at least 70% of possible return observations available it was not included in our performance database. A small number of ETFs were also excluded as a result of a preliminary analysis which indicated that they appeared to be outliers, probably due to a misinterpretation on our part as to the underlying benchmark index. Our performance database, after the process described above, contained 822 ETFs with a total MV of US$1.81 trillion, so we captured in our database 61% (=100(1.81/2.96)%) of ETFs by MV. The ETF with the most return observations in this database, 4755 dating from 1993, was the very first ETF, the SPDR Trust SPY, which tracks the S&P500. These 822 ETFs were associated with 444 different benchmark indices and are summarised in Exhibit 9. In total our performance database contained over 1.1m daily return observations.

INSERT EXHIBIT 9 HERE

To perform our analysis, we used returns based on the daily price changes, i.e. the return on an ETF at (trading) day t is r_t = (ETF price at day t minus ETF price at day t-1)/(ETF price at day t-1). We define the benchmark return B_t on day t for a $L\times$ ETF using B_t=L(ETF benchmark index return on day t), this allows us to compare $L\times$ ETFs with varying values for L (either positive or negative) in a consistent manner. Our use of simple returns, rather than log returns (i.e. r_t = ln(ETF price at day t/ETF price at day t-1)), is motivated by the fact that typically $L\times$ ETFs target simple return. Moreover if return is small then simple return and log return are approximately equal (Connor et al (2010)). However we would note in passing that log returns are common in quantitative finance and their use when we are interested in temporal behaviour has been recommended (Campbell et al (1997)).

Since the value of an index ignores transaction costs in its computation and the computation of the net asset value of an ETF takes transaction and management costs into account, the return on the ETF is likely to fall below that of the index it tracks. However, an investor holds an ETF with the expectation that its return behaviour $\{r_t\}$ will closely mimic the return behaviour $\{B_t\}$ of the underlying benchmark index, subject to these costs. The relative performances can be summarised by average return and volatility. Let us define:

$\mu_r = E(r_t)$ and $\sigma_r^2 = V(r_t)$ as the mean and variance of the ETF's return;

$\mu_B = E(B_t)$ and $\sigma_B^2 = V(B_t)$ as the mean and variance of the benchmark's return.

The difference in mean return is $(\mu_B - \mu_r)$ and the difference in volatility is measured by the difference in variances ($\sigma_B^2 - \sigma_r^2$).

Let us model the return of the ETF as a linear function of the benchmark:

$$r_t = \alpha + \beta B_t + \varepsilon_t \qquad \text{where } V(\varepsilon_t) = \sigma_\varepsilon^2 \tag{1}$$

Ideally the ETF perfectly reproduces the behaviour of the index and α is zero, β is unity and σ_ε^2 is zero. Underperformance occurs if $(\mu_B - \mu_r)$ is positive or (since $\mu_r = \alpha + \beta\mu_B$) if:

$$(1 - \beta)\mu_B - \alpha > 0 \tag{2}$$

Similarly $\sigma_r^2 = \beta^2\sigma_B^2 + \sigma_\varepsilon^2$, thus the ETF is more volatile than the benchmark ($\sigma_r^2 > \sigma_B^2$) if:

$$\sigma_\varepsilon^2 - (1 - \beta^2)\sigma_B^2 > 0 \tag{3}$$

Underperformance in mean return

In Exhibit 10, we compare the mean return of each ETF with that of its benchmark using all the data available for each benchmark (shown as % p.a.). The diagonal line in Exhibit 10 divides the plot into two triangles. Points in the top left (upper) triangle of the plot show ETFs which produce a greater mean return than their benchmarks ($\mu_r > \mu_B$); in general this outperformance is small. Points in the lower right triangle show ETFs whose mean return is less than that of their benchmarks; there are many examples of severe underperformance by ETFs. The distribution of $(\mu_B - \mu_r)$ is negatively skewed: the lower quartile is –1.61% p.a.; the median is 0.06% p.a.; the upper quartile is 2.48% p.a.; the 95 percentile is 10.80% p.a. Describing the variation in accuracy another way, only 34% (49%) of ETFs yielded a mean return within 1% p.a. (2% p.a.) of the benchmark return.

INSERT EXHIBIT 10 HERE

In order to gain insight into the relationship between ETF characteristics and their performance in replicating benchmark return the factors we consider are the degree of (inverse) leverage required; the category of the benchmark; the periods over which the returns were observed. The following regression was estimated:

$$\mu_B - \mu_r = \theta_0 + \theta_1 K_{-2} + \theta_2 K_{-1} + \theta_3 K_2 + \theta_4 \ln(\text{Market Value}) + \theta_5 \text{Cat(Bond)} + \theta_6 \text{Cat(Commodity)} + \theta_7 \text{Cat(Currency)} + \theta_8 \text{Cat(Multi-market)} + \theta_9 (\text{pre } 2000) + \theta_{10} (\text{pre } 2005) + \theta_{11} (\text{pre } 2007) + \theta_{12} (\text{pre } 2009) + \text{error} \quad (4)$$

where K_{-2} is a zero/one binary indicator that is unity if the ETF is inverse and leveraged by a factor of 2 or more (zero if not); K_{-1} indicates whether an ETF is inverse (non-leveraged), K_2 indicates whether an ETF is leveraged by a factor of 2 or more. Cat(Bond) is a binary indicator that is unity if the ETF is a Bond Tracker (zero if not); the other Cat() indicators are defined similarly. The binary indicators describing the start date of the ETF are set to unity if the start date is before the beginning of the year mentioned. If the ETF is a simple single equity market tracker with start date in February 2009, for example, then all the binary indicators are zero. A bond tracker starting in 2006, for example, would have Cat(Bond), (pre 2007) and (pre 2009) unity, all other binary indicators zero.

On a methodological issue it is clear that we could develop separate regression equations for separate categories of ETF. However the use of a single regression equation with binary indicators is common in the literature for analyses of the type presented here as it enables us to capture in a single equation the relative importance of different characteristics. Note also here that we are not hypothesising that ($\mu_B - \mu_r$) is zero, i.e. that an ETF exactly replicates benchmark return. Rather we are seeking insight into the relationship between ETF characteristics and benchmark replication.

Given equation (4) and the fact that underperformance occurs if ($\mu_B - \mu_r$) is positive a negative coefficient (θ_1 to θ_{12}) indicates a factor that contributes to reducing underperformance, a positive coefficient a factor that increases underperformance. For all of the regression results given in this paper we only regard a regression coefficient as significant if it has a *p*-value of 0.01 or less (so a 1% significance level).

The estimation results are summarised in Exhibit 11, where the significant regression coefficients have been highlighted. The R^2 value is only 11%, which means that much of the variation in ($\mu_B - \mu_r$) is unexplained. However, on average, both inverse trackers and leveraged trackers have significantly greater underperformance than a single equity tracker (since they have significant positive coefficients in Exhibit 11).

INSERT EXHIBIT 11 HERE

Looking at equation (2) underperformance can be decomposed into failing to fully capture the direction of changes in the benchmark, measured by $(1 - \beta)\mu_B$, or failing to capture the level of returns, measured by $-\alpha$. The median (upper quartile) value of $(1 - \beta)\mu_B$ is 0.00072% (0.00407%) per day, whereas the median (upper quartile) value of $-\alpha$ is -0.00069% (0.00830%) per day. To obtain more insight into the reasons for these failures, we repeat the regression in equation (4), firstly with $|1 - \beta|$ (using the deviation of β from one as a measure of failure to capture directional change) and secondly with α (as a measure of failure to capture the level of returns) as dependent variables.

The results are shown in Exhibit 12. Considering the left-hand panel first, only 20% of the variability of the deviations $|1 - \beta|$ are explained by ETF characteristics. Considering the significant coefficients, we see that inverse and/or leveraged ETFs tend to achieve β closer to one than simple single market equity ETFs. Bond ETFs also tend to achieve β closer to one. The positive coefficient associated with market value indicates that larger ETFs perform less well in capturing β. The negative coefficients associated with the start dates indicate that β is better captured by those ETFs with earlier start dates, but the effect is not significant for start dates earlier than 2000.

INSERT EXHIBIT 12 HERE

Considering the right-hand panel of Exhibit 12, we see that only 17% of the variation in α is explained by ETF characteristics. Inverse and/or leveraged ETFs tend to fail to reproduce the level of the benchmark return. There is a slight difference due to the type of benchmark, bonds tend to do worse than the rest. The positive coefficient associated with market value indicates that larger ETFs perform better.

In summary, a non-negligible proportion of ETFs underperform their benchmark in terms of return. Although there is a slight difference due to the type of index tracked, underperformance tends to be concentrated in inverse and leveraged ETFs. For each ETF, this underperformance is due to an aggregation of transaction and management costs coupled with inaccurate tracking (net of costs). Due to the complexity of constructing inverse and/or leveraged ETFs, we infer that inaccurate tracking is a major contributor to underperformance.

Underperformance in volatility

In Exhibit 13, we compare the volatility (% p.a.) of each ETF with that of its benchmark using all the data available for each benchmark. The diagonal line in Exhibit 13 divides the plot into two triangles. Points in the top left (upper) triangle of the plot show ETFs which are more volatile than their benchmarks ($\sigma_r > \sigma_B$); there are several ETFs where the excess volatility is very large. Points in the lower right triangle indicate instances where the ETF is less volatile than its benchmark; here the differences are small compared to the upper triangle. The distribution of the difference between the variance of the benchmark and the variance of the ETF, (σ_B^2 - σ_r^2), is negatively skewed. Describing this distribution in more familiar volatility per annum; the lower quartile is equivalent to a volatility difference of 15.77% p.a. and the median is equivalent to a volatility difference of 1.36% p.a. (where the ETF volatility exceeds that of the benchmark); the upper quartile is equivalent to a volatility difference of 1.80% p.a. (where ETF volatility is less than that of the benchmark). Looking at these data in another way, only 19% (28%) of ETFs yield an annual volatility within 1% p.a. (2% p.a.) of the volatility of their benchmark.

INSERT EXHIBIT 13 HERE

In order to gain insight into the relationship between ETF characteristics and their performance in replicating benchmark volatility the following regression was estimated:

$$\ln(\sigma_B^2/\sigma_r^2) = \theta_0 + \theta_1 K_{-2} + \theta_2 K_{-1} + \theta_3 K_2 + \theta_4 \ln(\text{Market Value}) + \theta_5 \text{Cat(Bond)} + \theta_6 \text{Cat(Commodity)} + \theta_7 \text{Cat(Currency)} + \theta_8 \text{Cat(Multi-market)} + \theta_9(\text{pre } 2000) + \theta_{10}(\text{pre } 2005) + \theta_{11}(\text{pre } 2007) + \theta_{12}(\text{pre } 2009) + \text{error} \quad (5)$$

where the indicators/variables are as previously defined above. The estimation results are summarised in Exhibit 14. Note here that given regression equation (5) a negative coefficient (θ_1 to θ_{12}) indicates a factor that contributes to greater excess volatility, a positive coefficient a factor that reduces excess volatility.

INSERT EXHIBIT 14 HERE

The R^2 of the regression is only 17% so much of the variation is unexplained. However, the variables that have a significant negative effect (leading to greater excess volatility) are those that identify the category of bond and multi-market tracker trackers.

From equation (3), we see that the difference in variance has two components: $(1 - \beta^2)\sigma_B^2$ due to failure to capture changes in benchmark returns; σ_ε^2 due to noise in the tracking process. These components are similar in importance, the median values are 0.61 and 0.88 (% per day)^2 respectively. We repeat the regression shown in equation (5), firstly with $(1 - \beta^2)$ as the dependent variable and secondly with $\ln(\sigma_\varepsilon^2)$ as the dependent variable. These results are summarised in Exhibit 15.

INSERT EXHIBIT 15 HERE

Considering the left-hand panel of Exhibit 15, the departures of β^2 from unity are not well explained by the regression with a R^2 value of only 15%; that is there is a large amount of unexplained variation. This is a similar analysis to the left-hand panel of Exhibit 12 with a different way of representing the departure of β from one; consequently the findings are similar with the extra suggestion that multi-market ETFs capture β better than single market ETFs.

Considering the right-hand panel of Exhibit 15, where $\ln(\sigma_\varepsilon^2)$ is the dependent variable, we are seeking to explain the extent of the variability in an ETF's tracking of its benchmark. This regression has a R^2 value of 30%. This variability increases for commodity and multi-market ETFs, decreases for bond and currency ETFs. The values for the start date coefficients suggest that variability increased during the period of the 2007-8 financial crisis.

To summarise, the volatility of the benchmark is exceeded by most ETFs; the discrepancy in volatility is caused in roughly equal proportions by failure to capture the direction and size of changes in returns of the benchmark (β) and by the variability in the tracking process (σ_ε^2). The type of benchmark mainly affected the variability, whereas the nature of the ETF (inverse and/or leveraged) mainly affected the capture of β. The variability in the tracking process increased during the recent financial crisis.

CONCLUSIONS

We have presented a snapshot of the current composition of the market for ETFs and its rapid growth. We identified 6937 ETFs with a total market value of US$2.96 trillion. Equities represent 70% of this market value; single market equity ETFs are concentrated on stocks from US, China and Japan; the largest proportion of multi-market equity ETFs follow emerging markets. Commodities, mainly gold and oil, represent 20% of ETF market value. Approximately one in eight ETFs is either an inverse tracker, a leveraged tracker or both. Our performance analysis, covering the period from 1993-September 2011, dealt with 822 ETFs with a total market value of US$1.81 trillion and over 1.1m daily return observations. This paper, both in terms of the snapshot and in terms of the performance analysis, dealt with the largest ETF dataset considered in the literature to date.

The accuracy with which ETFs replicate the behaviour of their benchmark is a mixed story. Using the data available to us from 1993 onwards, only 11% (19%) of ETFs reproduce both the mean return and the volatility of their benchmark within 1% p.a. (2% p.a.). We found that discrepancies in replicating the mean return of the benchmark tended to be associated with either leveraged or inverse (or both) ETFs. With respect to replicating benchmark volatility we found that most ETFs have higher volatility than their benchmarks. There was some evidence that discrepancies in replication of benchmark volatility was associated with commodity and multi-market ETFs; in contrast to bond and currency ETFs which tended to reproduce benchmark volatility more accurately than single market ETFs.

REFERENCES

Aber, Jack W., Dan Li and Luc Can (2009). Price volatility and tracking ability of ETFs, *Journal of Asset Management*, 10:210-221.

Ackert, Lucy F. and Yisong S. Tian (2008). Arbitrage, liquidity, and the valuation of exchange traded funds, *Financial Markets, Institutions & Instruments*, 17:331-362.

Agapova, Anna (2011). Conventional mutual index funds versus exchange-traded funds, *Journal of Financial Markets*, 14:323-343.

Agrrawal, Pankaj and John M. Clark (2007). ETF betas: A study of their estimation sensitivity to varying time intervals, *ETFs and Indexing*, 1:96-103.

Alexander, Carol and Andreza Barbosa (2008). Hedging index exchange traded funds, *Journal of Banking & Finance*, 32:326-337.

Avellaneda, Marco and Stanley Zhang (2010). Path-dependence of leveraged ETF returns, *SIAM Journal on Financial Mathematics*, 1:568-603.

Beasley, John E., Nigel Meade, and T-J Chang (2003). An evolutionary heuristic for the index tracking problem, *European Journal of Operational Research*, 148:621–643.

BlackRock (2011). ETP Landscape, Global Handbook, Q4 2011. Available from http://www2.blackrock.com/content/groups/internationalsite/documents/literature/etfl_globalhandbook_q411_ca.pdf accessed January 15 2014.

Blitz, David and Joop Huij (2012). Evaluating the performance of global emerging markets equity exchange-traded funds, *Emerging Markets Review*, 13:149–158.

Blitz, David, Joop Huij and Laurens Swinkels (2012). The performance of European index funds and exchange-traded funds. *European Financial Management*, 18:649–662.

Boehmer, Beatrice and Ekkehart Boehmer (2003). Trading your neighbor's ETFs: Competition or fragmentation? *Journal of Banking & Finance*, 27:1667-1703.

Borkovec, Milan and Vitaly Serbin (2013). Create or buy: a comparative analysis of liquidity and transaction costs for selected U.S. ETFs, *Journal of Portfolio Management*, 39(4):118-131.

Buetow, Gerald W. and Brian J. Henderson (2012). An empirical analysis of exchange-traded funds, *Journal of Portfolio Management*, 38(4):112-127.

Campbell, John Y., Andrew W. Lo and A. Craig MacKinlay (1997). The econometrics of financial markets, Princeton University Press, page 12.

Canakgoz, Nilgun A. and John E. Beasley (2009). Mixed-integer programming approaches for index tracking and enhanced indexation, *European Journal of Operational Research*, 196:384-399.

Charupat, Narat and Peter Miu (2011). The pricing and performance of leveraged exchange-traded funds, *Journal of Banking & Finance*, 35:966-977.

Cheng, Minder and Ananth Madhavan (2009). The dynamics of leveraged and inverse exchange-traded funds, *Journal of Investment Management*, 7(4):43-62.

Connor, Gregory, Lisa R. Goldberg and Robert A. Korajczyk (2010). Portfolio risk analysis, Princeton University Press, page 4.

De Jong Jr., Jack C. and S. Ghon Rhee (2008). Abnormal returns with momentum/contrarian strategies using exchange-traded funds, *Journal of Asset Management*, 9:289–299.

Deville, Laurent (2008). Exchange traded funds: History, trading and research, In Handbook of Financial Engineering, C. Zopounidis, M. Doumpos, P. Pardalos (Eds.), 1-37, Springer.

Dobi, Doris and Marco Avellaneda (2012). Structural slippage of leveraged ETFs Available from http://www.math.nyu.edu/faculty/avellane/LETF_Dobi_Avellaneda_Sept2012.pdf accessed January 15 2014.

Elston, Frank and Doug Choi (2009). Inverse ETFs, *Proceedings of the Academy of Accounting and Financial Studies*, 14:5-9.

Elton, Edwin J., Martin J. Gruber, George Comer and Kai Li (2002). Spiders: Where are the bugs? *Journal of Business*, 75:453-472.

Engle, Robert and Debojyoti Sarkar (2006). Premium-discounts and exchange traded funds. *The Journal of Derivatives*, 13(4):27-45.

Gastineau, Gary L. (2001). Exchange-traded funds: An introduction. And further likely evolution, *Journal of Portfolio Management*, 27:88-96.

Gastineau, Gary L. (2004). The benchmark index ETF performance problem: A simple solution, *Journal of Portfolio Management*, 30:96-103.

Gastineau, Gary L. (2010). The exchange-traded funds manual (2nd edition), Wiley Finance.

Giese, Guido (2010). On the risk-return profile of leveraged and inverse ETFs, *Journal of Asset Management*, 11:219-228.

Guedj, Ilan , Guohua Li and Craig McCann (2010). Leveraged and inverse ETFs, holding periods, and investment shortfalls, *The Journal of Index Investing*, 1:45-57.

Haga, Raymond and Snorre Lindset (2012). Understanding bull and bear ETFs, *The European Journal of Finance*, 18:149-165.

Henderson, Brian J. and Gerald W. Buetow (2014). The performance of leveraged and inverse leveraged exchange traded funds, *Journal of Investment Management*, 12:69-92.

Hlawitschka, Walter and Michael Tucker (2008). Utility comparison between security selectors, asset allocators and equally weighted portfolios within a selected ETF universe, *Journal of Asset Management*, 9:67–72.

IndexUniverse (2011). ETF briefing book: Key issues & supporting data. Available from http://www.indexuniverse.com/docs/ETFBriefingBook/IndexUniverseETFBriefingBook101811.pdf accessed January 15 2014.

Investment Company Institute (2013). Chapter 3: Exchange-traded funds. Available from http://www.icifactbook.org/fb_ch3.html accessed January 15 2014.

Jarrow, Robert A. (2010). Understanding the risk of leveraged ETFs, *Finance Research Letters*, 7:135-139.

Johnson, William F. (2009). Tracking errors of exchange traded funds, *Journal of Asset Management,* 10:253-262.

Kayali, Mustafa M. (2007). Pricing efficiency of exchange traded funds in Turkey: Early evidence from the Dow Jones Istanbul 20, *International Research Journal of Finance and Economics*, 10:14-23.

Kostovetsky, Leonard (2003). Index mutual funds and exchange-traded funds: A comparison of two methods of passive investment, *Journal of Portfolio Management*, 29:80-92.

Kupiec, Paul H. (1990). A survey of exchange-traded basket instruments, *Journal of Financial Services Research*, 4:175-190.

Lin, Victor and Phil Mackintosh (2010). ETF mythbuster: Tracking down the truth, *The Journal of Index Investing*, 1:95-106.

Little, Patricia K. (2010). Inverse and leveraged ETFs: Not your father's ETF, *The Journal of Index Investing*, 1:83-89.

Maister, Dominic, Mitchell Schorr and David Perlman (2009). ETFs: Average tracking error was well contained in 2008, *ETFs and Indexing*, 1:108-125.

Maister, Dominic, Mitchell Schorr, David Perlman and Stephen Minar (2010). Exchange-traded funds: Average tracking error rose meaningfully in 2009, *The Journal of Index Investing*, 1:132-163.

Mariani, M.C., J.D. Libbin, K.J. Martin, E. Ncheuguim, M.P. Beccar Varela, V. Kumar Mani, C.A. Erickson and D.J. Valles-Rosales (2009). Levy models and long correlations applied to the study of exchange traded funds, *International Journal of Computer Mathematics*, 86:1040–1053.

Marshall, Ben R., Nhut H. Nguyen and Nuttawat Visaltanachoti (2013). ETF arbitrage: intraday evidence, *Journal of Banking & Finance*, 37:3486-3498.

Poterba, James M. and John B. Shoven (2002). Exchange-traded funds: A new investment option for taxable investors, *American Economic Review*, 92:422-427.

Rollenhagen, Kristoph J. (2009). Pitfalls and potential: An attempt to demystify leveraged & inverse exchange-traded index funds*, ETFs and Indexing*, 1:105-107.

Rompotis, Gerasimos G (2008). Performance and trading characteristics of German passively managed ETFs, *International Research Journal of Finance and Economics*, 15:218-231.

Rompotis, Gerasimos G. (2009). Interfamily competition on index tracking: The case of the vanguard ETFs and index funds, *Journal of Asset Management,* 10:263-278.

Rompotis, Gerasimos G. (2011a). The performance of actively managed exchange-traded funds, *The Journal of Index Investing*, 1:53-65.

Rompotis, Gerasimos G. (2011b). A study on the third-generation exchange-traded funds: The case of short ETFs, *The Journal of Index Investing*, 2:25-43.

Rompotis, Gerasimos G. (2011c). Predictable patterns in ETFs' return and tracking error, *Studies in Economics and Finance*, 28:14-35.

Rompotis, Gerasimos G. (2012). A survey on leveraged and inverse exchange-traded funds, *The Journal of Index Investing*, 2:84-95.

Sabbaghi, Omid (2011). The behavior of green exchange-traded funds, *Managerial Finance*, 37:426-441.

Schmidhammer, Christoph, Sebastian Lobe and Klaus Roder (2011). Intraday pricing of ETFs and certificates replicating the German DAX index, *Review of Managerial Science*, 5:337-351.

Sharifzadeh, Mohammad and Simin Hojat (2012). An analytical performance comparison of exchange-traded funds with index funds: 2002–2010, *Journal of Asset Management*, 13:196-209.

Shin, Sangheon and Gokce Soydemir (2010). Exchange-traded funds, persistence in tracking errors and information dissemination, *Journal of Multinational Financial Management*, 20:214-234.

Tang, Hongfei and Xiaoqing E. Xu (2013). Solving the return deviation conundrum of leveraged exchange-traded funds, *Journal of Financial and Quantitative Analysis*, 48(1):309-342.

Tucker, Mathew and Stephen Laipply (2013). Bond market price discovery: clarity through the lens of an exchange, *Journal of Portfolio Management*, 39(2):49-62.

Thomson Reuters DataStream. (2011a). http://online.thomsonreuters.com/Datastream/ accessed January 15 2014.

Thomson Reuters DataStream. (2011b). Private communication.

Wong, Karen H.Y. and Wai Cheong Shum (2010). Exchange-traded funds in bullish and bearish markets, *Applied Economics Letters*, 17:1615-1624.

Exhibit 1. Papers dealing with the performance of ETFs

Paper	Scope	Conclusions
Elton et al (2002)	1 index tracking ETF; 1993-1998	ETF underperformed the index by 28.4bp (basis points)
Poterba and Shoven (2002)	1 index tracking ETF over 7 years	ETF returned 19.17% per year, a mutual fund 19.33%, the index 19.39%
Agrrawal and Clark (2007)	38 ETFs; 2002-2007	Regression of ETF return against market return indicates that regression slopes (beta's) are not affected by return frequency, but are affected by estimation period
De Jong and Ghon Rhee (2008)	Up to 217 ETFs with weekly data; 1996-2005	Momentum and contrarian strategies will yield significant excess returns
Hlawitschka and Tucker (2008)	9 ETFs; 2002-2005	Performance of a mean/variance portfolio drawn from the major stock constituents of the ETFs superior to other portfolios examined
Rompotis (2008)	62 German ETFs with weekly data; 2000-2006	ETFs slightly underperform their benchmark indices; they have greater risk (standard deviation in return) than their indices
Aber et al (2009)	4 index tracking ETFs	Mixed picture as to tracking ability with respect to returns achieved
Elston and Choi (2009)	1 *-1×* ETF and 5 *-2×* ETFs in 2008	5 of the 6 ETFs underperformed with respect to their target return
Johnson (2009)	Daily and monthly data for 20 index tracking ETFs; 1997-2006	Explanatory factors for the correlations found included return relative to USA index and overlapping exchange opening hours
Maister et al (2009)	505 US-listed ETFs in 2008	Average difference between NAV return and index return was 52bp
Rompotis (2009)	20 index tracking ETFs; 2004-2006	ETFs slightly underperform their benchmark indices
Maister et al (2010)	563 US-listed ETFs in 2009	Average difference between NAV return and index return was 125bp
Shin and Soydemir (2010)	26 ETFs with daily data; 2004-2007	ETFs underperform their benchmark indices
Wong and Shum (2010)	Daily performance of 15 ETFs; 1999-2007	ETF returns are higher in bullish, than bearish, markets; some ETFs with the same benchmark index perform differently
Agapova (2011)	Monthly performance of 11 ETFs with comparable index tracking funds; 2000-2004	Very few significant differences between ETFs and index tracking funds
Charupat and Miu (2011)	8 Canadian leveraged (*2×*, *-2×*) ETFs, compared with four non-leveraged (*1×*, *-1×*) ETFs	Leveraged ETFs more actively traded than non-leveraged ETFs; daily returns regression indicated that the ETFs were giving returns close to the *±2×* promised
Rompotis (2011a)	14 actively managed ETFs; 2008-2010	No significant difference with regard to average daily return and risk when comparing the ETFs to the S&P500
Rompotis (2011b)	37 inverse leveraged (*-2×*, *-3×*) ETFs; 2006-2011	ETFs underperform their daily target return
Rompotis (2011c)	50 index tracking ETFs; 2002-2007	ETFs outperformed the S&P500; tracking error with respect to the benchmark index is strongly persistent in the short term
Sabbaghi (2011)	15 green ETFs; 2005-2009	Positive cumulative returns from inception through to end of 2008, negative thereafter
Schmidhammer et al (2011)	5 ETFs and 3 index certificates replicating the DAX; minute prices over two months in 2008	ETFs based on complete replication perform better than index certificates or ETFs based on swaps
Blitz and Huij (2012)	7 global emerging markets equity ETFs; inception-December 2010	High levels of tracking error, higher than developed market ETFs
Blitz et al (2012)	3 European ETFs; 2003-2008	Dividend taxes and expense ratios contribute to underperformance
Buetow and Henderson (2012)	845 US-listed ETFs; 1994-2010	On average ETFs closely track their benchmark index
Haga and Lindset (2012)	4 Norwegian leveraged (*2×*, *-2×*) ETFs; January 2008-May 2010	Regression indicated that the ETFs are not achieving the *±2×* returns promised
Rompotis (2012)	68 leveraged and inverse (*2×*, *-1×*, *-2×*, *-3×*) ETFs	ETFs are not achieving the returns promised; majority of daily returns deviate from the target multiple by at least 10bp
Sharifzadeh and Hojat (2012)	34 ETFs, matched with passive index mutual funds; 2002-2010	No statistical support for the hypothesis that ETFs outperform index funds; no overall difference between ETFs and index funds in terms of Sharpe ratio
Tang and Xu (2013)	12 leveraged and inverse (*2×*, *-1×*, *-2×*) ETFs; 2006-2010	Deviation from desired return due to combination of management tracking error and market frictions/inefficiencies
Henderson and Buetow (2014)	98 leveraged and inverse (*3×*, *2×*, *-1×*, *-2×*, *-3×*) ETFs; 2006-2012	Underperformance found for leveraged short ETFs, excess returns found for leveraged ETFs

Exhibit 2. Cumulative number of ETFs over time

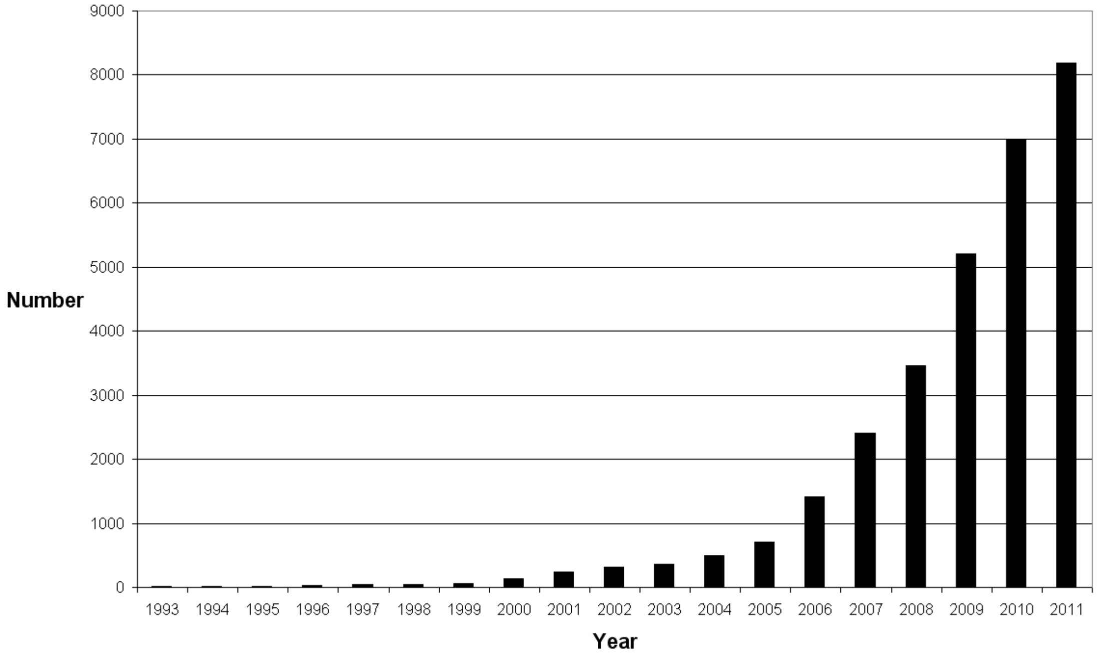

Exhibit 3. ETF summary by number within each major and sub-classification and performance type

Major Classification (no. active)	Sub-Classification	*1×*	*-1×*	*2×*	*-2×*	*3×*	*-3×*	**Excess Return**	**Other**	**Active**	**Dead**
Bond Tracker (860)	Bond Index	785	41	5	6	2	2	6		847	102
	Bonds	1	2	5	5					13	1
Commodity Tracker (935)	Commodity	244	15	18	7			4	4	292	7
	Commodity Futures	7	1	2	3			13		26	8
	Commodity Index	428	40	74	2			31		575	0
	Commodity Index 3 month forward	42								42	0
Currency Tracker (202)	Currency	66	42	3	3	14	14			142	4
	Currency Index	42	1							43	0
	Interest Rate Index	17								17	4
Derivative Tracker (2)	General	2								2	1
Hedge Fund Tracker (26)	Hedge Fund Index	26								26	11
Inflation Tracker (2)	Inflation Index							1		1	0
	Interest Rate Index	1								1	0
Interest Rate Tracker (1)	Interest Rate Index		1							1	0
Loan Market Tracker (1)	Loans	1								1	0
Multi-Market Equity Tracker (2272)	Futures	5								5	0
	General	1215	26	40	33	3	3	1		1321	159
	Real Estate Sector	66								66	8
	Sector	760	44	4	4	1	1			814	118
	Specialised	66								66	17
Multi-Asset Index Tracker (16)	Comm. or Bond or Equity/Currency Index	1							5	6	0
	General	10								10	0
Real Estate Tracker (9)	Mortgage	4								4	2
	Real Estate Index	5								5	0
Single Market Equity Tracker (2607)	Futures	10		1						11	1
	General	1763	86	92	59	10	8		2	2020	210
	Real Estate Sector	49	1	1	2	1	2			56	10
	Sector	416	8	20	17	7	6			474	106
	Specialised	46								46	22
Volatility Tracker (4)	Implied Volatility Index	2								2	0
	Volatility Index	2								2	0
Total		**6082**	**308**	**265**	**141**	**38**	**36**	**56**	**11**	**6937**	**791**
Percentage of active ETFs		**87.7**	**4.4**	**3.8**	**2.0**	**0.5**	**0.5**	**0.8**	**0.2**		

Notes:

(a) A multi-market equity tracker means that the ETF benchmark index contains stocks from two or more national/country markets (for example the S&P1200)

(b) A single market equity tracker means that the ETF benchmark index contains stocks from only one national/country market (for example the FTSE100)

(c) Real estate trackers track property price indices, in equity indices the real estate sector trackers follow indices related to stocks in real estate companies

(d) Specialised equity trackers track indices that are subject to specific policies, such as Islamic indices

(e) For bond, commodity and currency trackers some track indices and others track prices (or future prices)

(f) There are 7728 ETFs above, we were unable to find sufficient information to accurately classify 464 (approximately 5.7%) of the 8192 ETFs in our snapshot (this classification is not automatic in DataStream but must be done manually, e.g. by individually examining each ETF website)

Exhibit 4. Number of active ETFs by year of introduction and category

Year	Single Market Equity Tracker	Multi-Market Equity Tracker	Commodity Tracker	Bond Tracker	Currency Tracker	Hedge Fund Tracker	Multi-Asset Index Tracker	Real Estate Tracker	Others	Total
1993	1									**1**
1994										
1995	2									**2**
1996	18									**18**
1997	2									**2**
1998	9	2								**11**
1999	5	1								**6**
2000	47	7		2						**56**
2001	46	15						1		**62**
2002	25	11		4						**40**
2003	19	10	1	9						**39**
2004	62	48	4	12						**126**
2005	79	53	7	11	1					**151**
2006	234	174	92	55	7		2	1	1	**566**
2007	287	272	151	98	7		2	1	1	**819**
2008	293	340	135	64	34		5	1		**872**
2009	401	462	182	249	53	7		3	3	**1360**
2010	663	509	260	194	62	7			1	**1696**
2011 (part year)	414	368	103	162	38	12	7	2	4	**1110**
Total	**2607**	**2272**	**935**	**860**	**202**	**26**	**16**	**9**	**10**	**6937**

Exhibit 5. ETF market value (MV) summary

Classification	Number active	Number with available MV	% with available MV	Total MV (US$m)	MV % total	Mean ETF MV (US$m)	Median ETF MV (US$m)	Ratio (mean/ median)
Bond Tracker	860	252	11.9	238167.7	8.1	945.1	80.7	11.7
Commodity Tracker	935	157	7.4	618330.9	20.9	3938.4	66.0	59.7
Currency Tracker	202	42	2.0	55296.2	1.9	1316.6	112.2	11.7
Derivative Tracker	2	2	0.1	148.8	0.0	74.4	74.4	1.0
Hedge Fund Tracker	26	5	0.2	444.0	0.0	88.8	29.7	3.0
Inflation Tracker	2	1	0.0	26.0	0.0	26.0	26.0	1.0
Loan Market Tracker	1	1	0.0	166.4	0.0	166.4	166.4	1.0
Multi-Market Equity Tracker	2272	473	22.3	484177.2	16.4	1023.6	58.7	17.4
Multi-Asset Index Tracker	16	14	0.7	1492.7	0.1	106.6	77.7	1.4
Real Estate Tracker	9	7	0.3	6044.9	0.2	863.6	50.9	17.0
Single Market Equity Tracker	2607	1171	55.1	1551126.2	52.5	1324.6	63.7	20.8
Unclassified Others	5	0	0.0	0.0	0.0	0.0	0.0	n.a.
Total	6937	2125		2955421.0				

Exhibit 6. Single market equity ETFs: the top 20 countries by market value, showing percentage of total by market value and number of ETFs

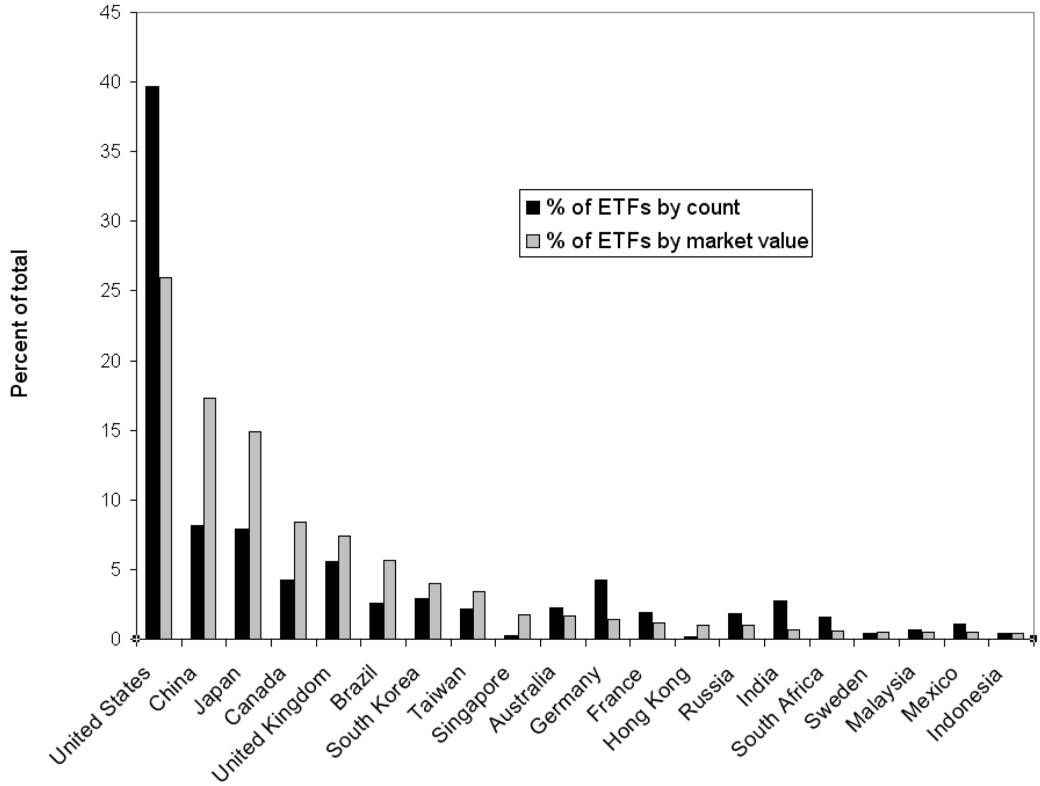

Exhibit 7. Multi-market equity ETFs: the top 20 indices by market value, showing percentage of total by market value and number of ETFs

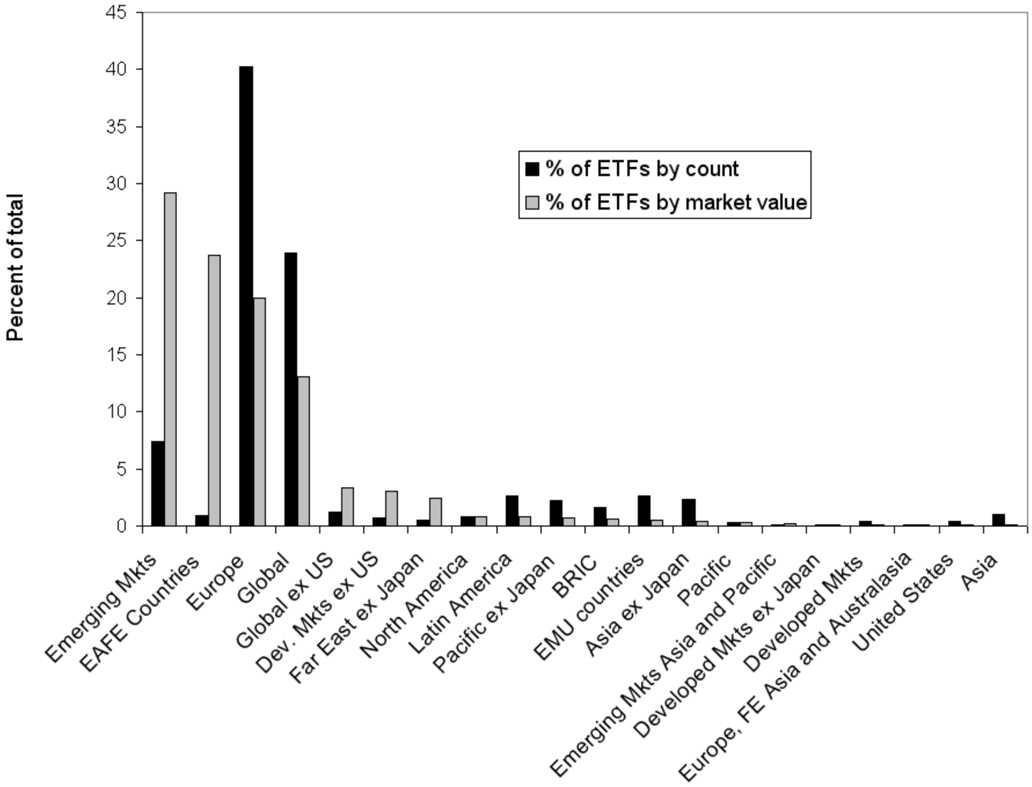

Exhibit 8. Commodity ETFs: the top 10 commodity or commodity indices by market value, showing percentage of total by market value and number of ETFs

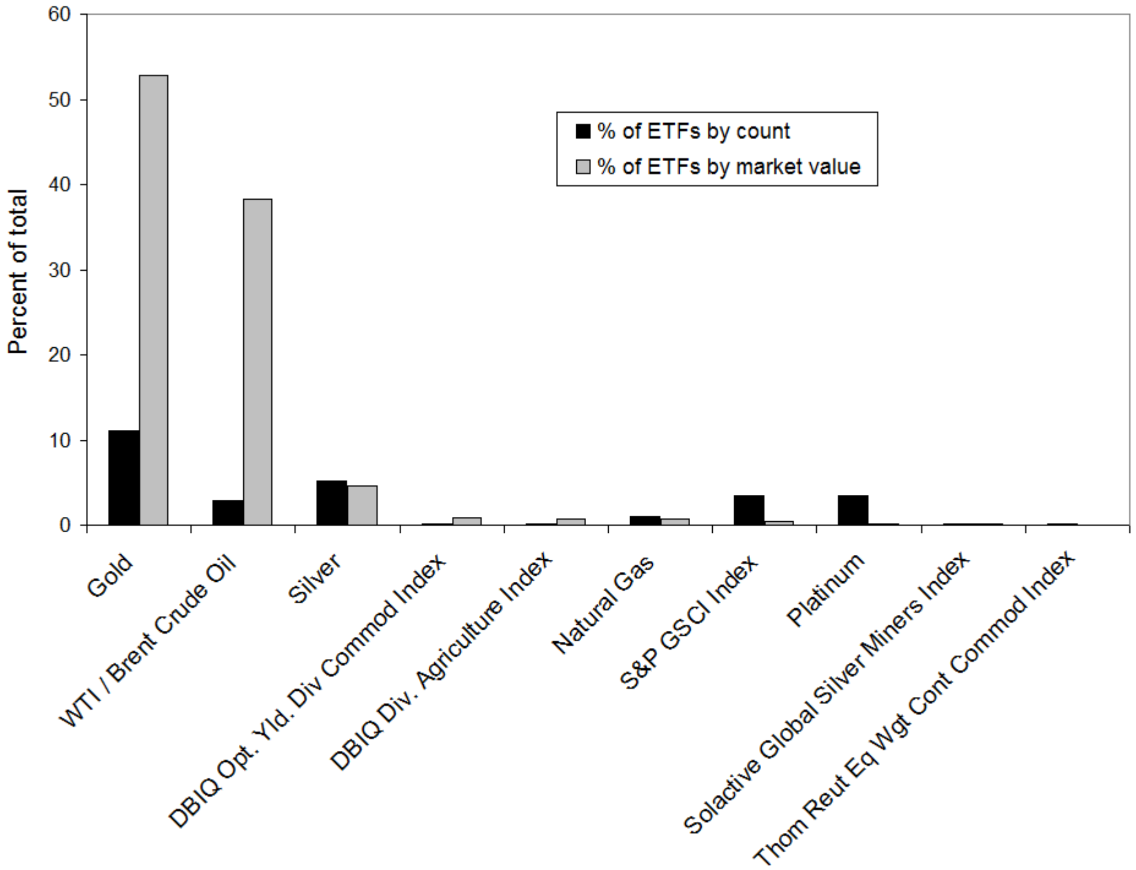

Exhibit 9. Performance database summary

Classification	Number	Total MV (US$m)	Total number of daily return obs.	Sub-classification	Number	Total MV (US$m)	Total number of daily return obs.
Bond Tracker	59	166563.1	66729	Bond Index	59	166563.1	66729
Commodity Tracker	57	368415.2	58779	Commodity	37	353725.2	36814
				Commodity Futures	1	199.5	1002
				Commodity Index	19	14490.4	20963
Currency Tracker	21	5691.7	21087	Currency	21	5691.7	21087
Derivative Tracker	2	148.8	2354	General	2	148.8	2354
Multi-Market Equity Tracker	204	406926.6	256404	General	139	361891.1	182252
				Real Estate Sector	8	3004.6	7146
				Sector	55	41806.3	64741
				Specialised	2	224.5	2265
Multi-Asset Index Tracker	4	373.4	3086	General	4	373.4	3086
Real Estate Tracker	4	5941.8	5448	Mortgage	2	3652.7	1867
				Real Estate Index	2	2289.1	3581
Single Market Equity Tracker	471	856040.3	724034	General	322	747545.0	506412
				Real Estate Sector	16	20478.0	21829
				Sector	130	87716.2	191774
				Specialised	3	301.1	4019
Total	**822**	**1810100.9**	**1137921**	**Total**	**822**	**1810100.9**	**1137921**

Tracking policy	Number	Total MV (US$m)	Total number of daily return obs.
-3×	6	1743.7	4299
-2×	55	14825.7	54380
-1.5×	1	246.7	1462
-1×	16	5221.0	14840
1×	686	1774446.0	1007181
2×	51	11462.2	50720
3×	7	2155.8	5039
Total	**822**	**1810100.9**	**1137921**

Exhibit 10. A comparison of ETF mean return with that of its benchmark. The mean is calculated over all available data.

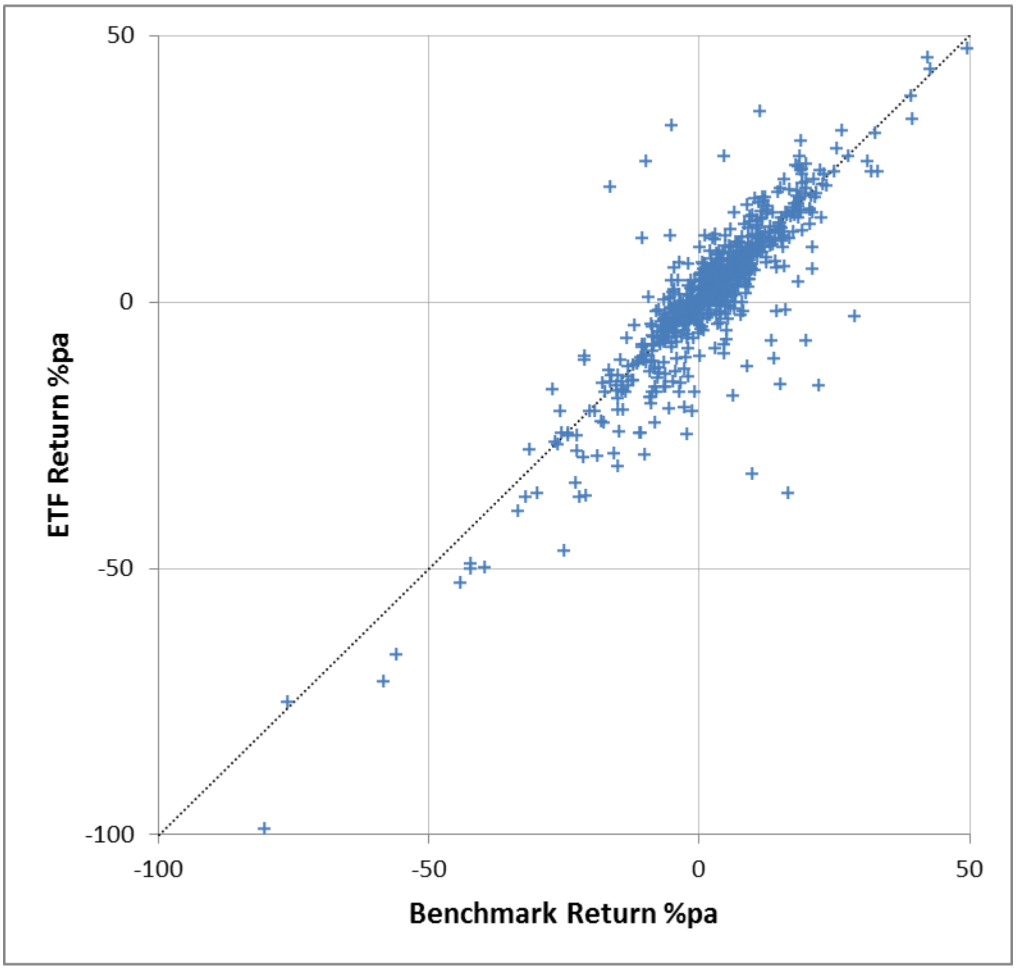

Exhibit 11. Regression to explain ($\mu_B - \mu_r$) in terms of ETF characteristics

Analysis of ($\mu_B - \mu_r$)
R^2=0.11

	Coefficient	*Standard Error*	*p-value*
Intercept	-0.005	0.004	0.19
K_{-2}	***0.029***	***0.004***	***0.00***
K_{-1}	***0.019***	***0.007***	***0.01***
K_2	***0.014***	***0.004***	***0.00***
ln(MV)	-0.001	0.001	0.09
Bond	0.009	0.004	0.02
Commodity	0.000	0.004	0.99
Currency	-0.007	0.006	0.24
Multi-market	0.000	0.002	0.93
pre 2000	0.001	0.005	0.90
pre 2005	-0.001	0.003	0.78
pre 2007	-0.000	0.003	0.92
pre 2009	***0.010***	***0.003***	***0.00***

Exhibit 12. Two regressions to decompose the underperformance of an ETF in terms of ETF characteristics

Analysis of |1 - β| R^2=0.20				**Analysis of α** R^2=0.17			
	Coefficient	*Standard Error*	*p-value*		*Coefficient*	*Standard Error*	*p-value*
Intercept	***0.322***	***0.038***	***0.00***	***Intercept***	***0.015***	***0.004***	***0.00***
K_{-2}	***-0.190***	***0.040***	***0.00***	***K_{-2}***	***-0.034***	***0.004***	***0.00***
K_{-1}	***-0.253***	***0.071***	***0.00***	***K_{-1}***	***-0.025***	***0.008***	***0.00***
K_2	***-0.207***	***0.040***	***0.00***	***K_2***	***-0.011***	***0.004***	***0.01***
ln(MV)	***0.035***	***0.005***	***0.00***	***ln(MV)***	***0.002***	***0.001***	***0.00***
Bond	***-0.102***	***0.040***	***0.01***	***Bond***	***-0.011***	***0.004***	***0.01***
Commodity	-0.067	0.040	0.09	Commodity	0.004	0.004	0.30
Currency	-0.054	0.063	0.39	Currency	0.008	0.007	0.26
Multi-market	-0.035	0.024	0.14	Multi-market	-0.004	0.003	0.13
pre 2000	0.004	0.053	0.94	pre 2000	-0.002	0.006	0.72
pre 2005	***-0.153***	***0.031***	***0.00***	pre 2005	-0.001	0.003	0.66
pre 2007	***-0.114***	***0.028***	***0.00***	pre 2007	0.004	0.003	0.17
pre 2009	***-0.138***	***0.030***	***0.00***	***pre 2009***	***-0.023***	***0.003***	***0.00***

Exhibit 13. A comparison of ETF volatility with that of its benchmark. Volatility is calculated over all available data.

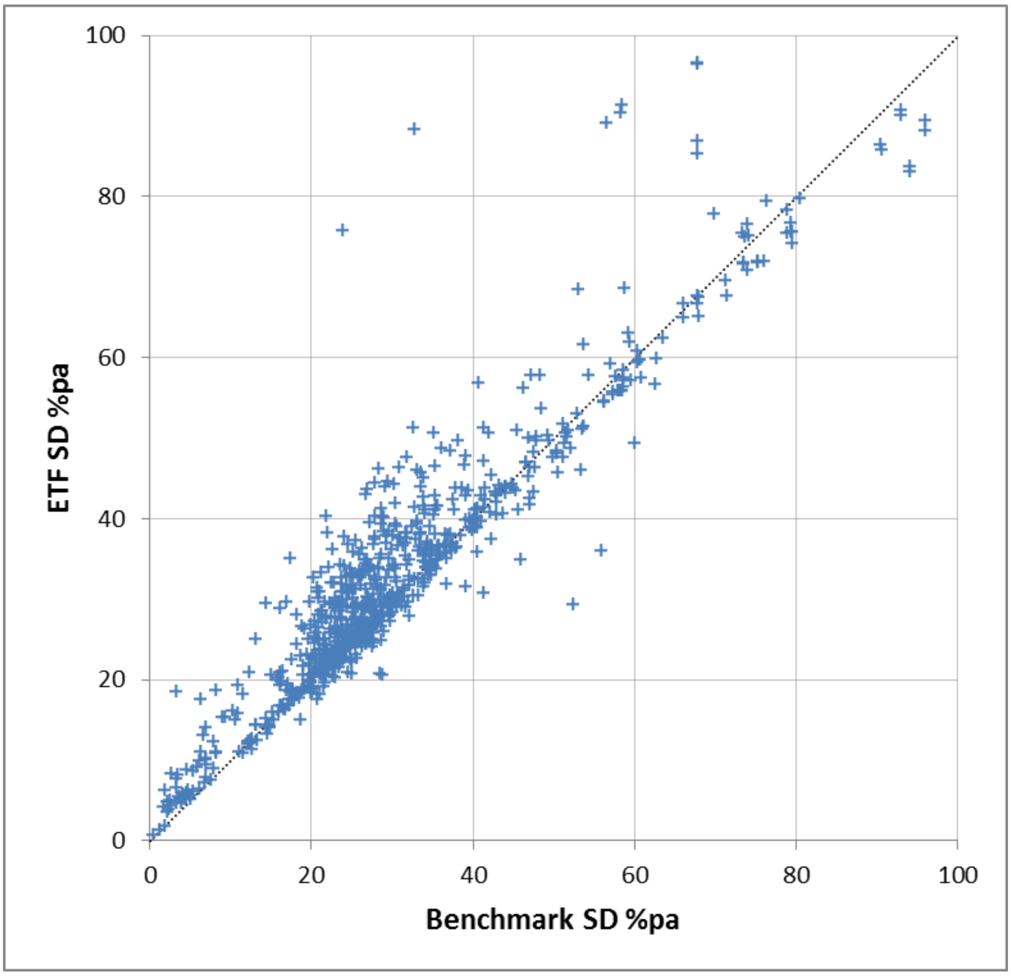

Exhibit 14. Regression to explain the difference between the volatility of an ETF and that of its benchmark in terms of ETF characteristics

Analysis of ln(σ_B^2 / σ_r^2)

R^2=0.17

	Coefficient	*Standard Error*	*p-value*
Intercept	-0.126	0.056	0.03
K_{-2}	0.062	0.059	0.29
K_{-1}	0.161	0.106	0.12
K_2	***0.192***	***0.060***	***0.00***
ln(MV)	-0.008	0.070	0.27
Bond	***-0.586***	***0.059***	***0.00***
Commodity	-0.004	0.059	0.95
Currency	-0.135	0.093	0.15
Multi-market	***-0.211***	***0.035***	***0.00***
pre 2000	-0.190	0.078	0.02
pre 2005	0.044	0.047	0.34
pre 2007	0.088	0.042	0.35
pre 2009	-0.005	0.045	0.92

Exhibit 15. Regressions looking at a decomposition of the difference between the volatility of an ETF and that of its benchmark in terms of ETF characteristics

Analysis of (1 - β^2)

R^2=0.15

	Coefficient	*Standard Error*	*p-value*
Intercept	***0.415***	***0.045***	***0.00***
K_{-2}	***-0.206***	***0.047***	***0.00***
K_{-1}	***-0.247***	***0.084***	***0.00***
K_2	***-0.214***	***0.047***	***0.00***
ln(MV)	***0.031***	***0.006***	***0.00***
Bond	-0.031	0.047	0.51
Commodity	0.009	0.047	0.84
Currency	0.014	0.074	0.85
Multi-market	***-0.076***	***0.028***	***0.01***
pre 2000	0.050	0.062	0.41
pre 2005	***-0.119***	***0.037***	***0.00***
pre 2007	***-0.133***	***0.033***	***0.00***
pre 2009	***-0.145***	***0.036***	***0.00***

Analysis of ln(σ_ε^2)

R^2=0.30

	Coefficient	*Standard Error*	*p-value*
Intercept	-0.053	0.174	0.76
K_{-2}	0.307	0.180	0.08
K_{-1}	***-0.859***	***0.324***	***0.01***
K_2	-0.227	0.183	0.21
ln(MV)	-0.021	0.023	0.35
Bond	***-1.712***	***0.181***	***0.00***
Commodity	***0.469***	***0.181***	***0.01***
Currency	***-1.048***	***0.284***	***0.00***
Multi-market	***0.684***	***0.108***	***0.00***
pre 2000	***0.892***	***0.239***	***0.00***
pre 2005	***-0.773***	***0.142***	***0.00***
pre 2007	***-0.657***	***0.128***	***0.00***
pre 2009	0.312	0.137	0.02